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THE NEW YORK UNDERGROUND RAILWAY.

The breaking of ground last week in New York for the underground railway brought to the point of realization plans for rapid transit which first took formal shape almost fifteen years ago. In the early years the question of tractive power was perhaps the most important one involved in the success of the movement for the construction of the proposed underground road. The development of electric railway engineering since then has rendered available an ideal solution for what, when joined with the opposition of corrupt political forces until but lately successfully maintained, would otherwise have retarded for years more the realization of the project. It can therefore be said with confidence that the people of New York will owe to electricity the benefits which underground rapid transit will soon bestow.

THE METROPOLITAN POWER STATION.

For the production of a thoroughly high-grade street-railway power station no more ideal conditions could have been found than those that surrounded the design and erection of the power generating equipment of the Metropolitan Street Railway Company in New York City, a description of which is begun on another page of this issue. Upheld by public sentiment from putting in the overhead trolley in New York City, the company had no electric lines until power station engineering had reached a much more highly developed state than when most of the large companies in this country began their electrical development. Unhampered by existing stations laid out on older plans, the company was free to design its equipment without regard to apparatus already in use and too valuable to be discarded. Having already developed the largest, most condensed and most profitable traffic of any traction system in this country or in the world, the company was able to foretell its load with more than usual accuracy and was financially able to obtain the best equipment regardless of first cost.

The result is the largest railway power plant in the world, containing the largest engine-driven generators ever built, distributing high-tension polyphase current to substations containing the largest equipments of rotary converters and storage batteries ever used for any purpose. The development of so great an electrical power, 50,000 to 60,000-hp, in the high-tension form—6600 volts—gives rise to unusual risks which require unusual precautions against break-down or failure of continuity of service. A system so large also warrants the use of unusually elaborate controlling arrangements and economy refinements. In consequence, there have necessarily been embodied in the electrical part of this power system many new features which render it a notable step forward in electrical engineering. Among these features are the design of the generators, the new form of electropneumatic oil switch with overload and reverse-current relays for rendering it an automatic circuit breaker, the six-phase rotary converters, the provisions against the spreading of burn-outs, the unusual design of the busbars, etc. All of these will be described with rather unusual detail in succeeding sections of the article referred to above as beginning on another page of this issue.

TWO ENGLISH CENTRAL STATIONS.

That English central-station practice has gone through a process of transformation similar to American practice, is shown by the article on another page describing two alternating-current central sta-

tions in London. Originally equipped with 100-cycle single-phase machines, the plants are now being changed over to 50-cycle two-phase for the same reason that American practice is changing from 125 cycles single-phase to 60 cycles with two or three phases.

A unique feature of the English plants which might be imitated with profit by some American stations working under similar conditions, is the use of alternating-current motor-generators connecting the high and the low-frequency busbars. By means of these machines the low-frequency generating units can be assisted by the high-frequency generators if the low-frequency load is a little too great for the number of machines connected, the capacity of the high frequency machines working being sufficiently greater than the high-frequency load to supply the difference. In case the capacity of the low-frequency sets in operation exceeds the demand, the power can be transferred from the low-frequency to the high-frequency busbars. At times of light load, when one generating unit of either class is sufficient to carry the loads of both, the motor-generator avoids the need of running two engine-driven units under light loads. If such a motor-generator is intended simply to transform power from one set of busbars to the other, one or more engine-driven generators at all times running on each frequency, either or both ends of the motor-generator may be made of the induction type. If at all times one of the low-frequency engine-driven ends is to be in operation, the low-frequency end of the motor-generator may be of the induction type, the other end being necessarily of the synchronous type in order to deliver high-frequency currents when no high-frequency engine units are in operation. If it is expected to run the motor-generator at times of light load, transforming either from the high to the low frequency or the low to the high frequency, its generating end in either case not being in parallel with any engine-driven machines, then both ends of the motor-generator must be of the synchronous type. This has the advantage that the high-frequency plant must be, so to speak, synchronized with the low-frequency plant before the motor-generator can be put in operation, and that the transference of the load from one to the other can only be adjusted by varying the relative steam admission of the two classes of generating sets when running at suitable speeds to operate in parallel with each other. If one or both ends of the motor-generator is of the induction type there will be a greater flexibility in the speed relation between the two sets of machines.

SUSPENDED MOTOR CAR TRACTION.

Elsewhere in this issue will be found a description of a singular type of electric railway now in course of construction in Germany. An interesting feature of the railway is the location of the suspension structure for the greater part of its length over a water course. The odd, though not particularly novel, feature is the suspension of the motor car from the tractive trucks. We are unable to offer the arguments in favor of this departure from current practice, but they were at least sufficiently plausible to enlist capital for carrying out the system on a considerable scale. It would appear that the tractive resistance offered when a weight is moved on a truck along a rail is independent of the position of the centre of gravity of the weight with respect to the rail. Numerous inventors, however, have taken an opposite view, and though not a few have enlisted capital to have their ideas tested experimentally, the prosaic method of maintaining the centre of gravity in a natural relation with the rail still continues the current practice. The German road will furnish an excellent opportunity to test the inverted centre of gravity theory, for it appears to have been excellently designed in all of its structural details.

POLYPHASE MOTORS FOR ELECTRIC TRACTION.

In our issue of Feb. 10 there were discussed in these columns some of the difficulties to be overcome in the adaptation of polyphase motors to electric traction. An interesting correspondence on the subject has followed, an addition to which appears in this issue in a letter from Mr. J. J. Heilmann, who is well known for his work in the application of electricity to heavy traction purposes. Among the points mentioned in the editorial were the small airgap required in polyphase motors in order to reduce lagging currents, and probable difficulties in the construction of a type of motor suitable for railway use owing to the inherent low magnetic density and the alternative of large diameter or high rotative speed.

In commenting upon the editorial, Mr. George T. Hanchett pointed out that while the objection to lagging currents might apply to ordinary street railway service, it had little weight in the application of the polyphase motor to interurban and similar service; and that even in classes of work necessitating frequent stops, line lagging currents could be compensated for by means of condensers, or the use of rotary converters on the distributing system. As to the low power factor and the difficulty of providing a small airgap, he pointed out that polyphase motors have a short length along the axis of rotation, and as the rotating part of the machines is usually hollow, the conditions are ideal for substantial bearings of considerable length, and consequently small airgap; moreover, as the field is a rotating one, the bearings will tend to wear much more uniformly than in the case of direct current motors. Mr. Hanchett also gives a calculation showing that the available space under a car body for the installation of a motor is sufficient to accommodate an induction motor running at a speed—assuming a frequency of 25 cycles—not exceeding that of single-reduction, direct-current railway motors. Mr. B. A. Behrend does not consider the small airgap an insuperable drawback nor the employment of a frequency as low as 25. In his opinion the main objection to the use of polyphase motors for electric traction is the necessity of having to use two trolleys. Dr. Bell points out that a comparison is unfair between the highly specialized direct-current railway motor of to-day—the result of ten years of persistent modification to adapt it to its purpose—and the present commercial induction motor, as designed for ordinary service at the usual frequencies. With a proper design of induction motor and with a low frequency, Dr. Bell considers that the matter of power factor cuts a small figure.

The points above noted all appear to be well taken, and another advantage of the polyphase motor for traction work which may be added is its ability to automatically feed back into the line when running above speed, thereby also acting as a mechanical brake. On the other hand, a weakness not referred to lies in the fact that the alternating current motor cannot be made as efficient in starting as the direct-current series motor such as is used in railway work; but in service where the stops are infrequent, such as in long-distance traffic, this point loses its importance. Mr. Hanchett's criticism that the objection to the induction motor is most prominent when starting, since at this moment is required the largest wattless current, is not correct if the starting torque is obtained by the use of armature resistance, in which case the power factor at starting will be just as high as with the same torque when running. It is true that the criticism is valid with respect to the squirrel-cage armature type of motor, but it is doubtful if such motors will be used. It is probable that definitely wound armatures and external starting resistance would instead be chosen, at least as long as we use a frequency of 25 cycles or higher. It is probable, however, that for traction work the frequency would be lowered, particularly if step-down transformers are used on the motor cars instead of in substations, which is entirely practicable with respect to cost.

From the discussion it appears that with induction motors operated

on very low frequency circuits, extremely high power factors can be obtained with short-circuited armatures even in starting. For example, a standard railway motor with, say, 1-16-in. clearance would have in starting or at full load, a power factor of about 90 per cent. if operated on a 25-cycle circuit. This means only 10 per cent. more current than that representing power. Furthermore, the effect on the generator need not be very serious, since automatic potential controlling devices have been developed and are now in use which will satisfactorily take care of voltage fluctuations, no matter what the power factor of the load may be. There is no doubt that an air-gap of 1-16-in. and even smaller would be entirely practicable, since the induction motor has no commutator and the bearings, as stated above can be brought far under the armature, and the length of shaft and the incidental tendencies to vibration thus greatly lessened.

ELECTRIC "TOUCH."

Prof. Jagadis Chunder Bose, of Calcutta, has recently presented an interesting and important paper to the British Royal Society upon the effects produced in the molecules of substances exposed to electromagnetic waves. The coherer of wireless telegraphy, as is well known, is an "electric eye," or an organization which responds to the impact of long electromagnetic waves or invisible light. The eye consists of a little heap of metal filings contained in a small glass tube between a pair of metallic electrodes, and the effect of an electromagnetic wave or train of waves upon this eye is suddenly to increase the conductivity of the mass. It has been supposed that this increased conductivity was a molar or mass effect, as distinguished from a molecular effect, and that the successive particles in the filing heap were welded together by minute electric sparks passing between them, thereby rendering metallically continuous a previously discontinuous metallic mass. It has, in fact, been declared that under the microscope these little sparks could be detected between the filings at the moment of the passage of the electromagnetic waves.

Prof. Bose shows, however, that while molar action may take place between neighboring particles of a coherer, yet, broadly speaking, the action is deeper seated and is molecular. When an electric wave impinges upon a substance the molecules in the surface are modified in their structure; that is to say, it is supposed that the arrangement of the atoms in the molecule is altered so that an allotropic modification of the same chemical substance is obtained as the "radiation product." The radiation product is chemically the same as the original substance, but is physically different, in the same way that graphite and soot may be considered to be allotropic varieties of carbon.

Not only is the mechanism of the coherer effect less simple than at first sight appears, but the effect itself is also more complex. It is shown that some substances in receivers increase in resistance upon electromagnetic wave stimulus instead of diminishing in resistance like iron filings. An arsenic receiver is said to become practically non-conducting under certain conditions, when acted upon by non-luminous electromagnetic waves. In this sense arsenic has a negative electric touch, as compared with iron, and a receiver of arsenic could not properly be called a coherer; if anything, it should be called a decoherer. Moreover, the same receiver may diminish in resistance with powerful radiation and increase in resistance with feeble radiation; or, be positive in strong, and negative in weak radiation. This effect appears to have been also noticed by Dr. Lodge in the case of iron. It is stated that an iron-filing receiver may show positive touch, or fall in resistance, when exposed to radiation from a source up to, and within, a distance of 25 centimeters from that source. A critical distance is then reached at which no influence is felt. Beyond this critical distance the touch is negative or the incident rays produce increase of resistance. A receiver of freshly powdered arsenic behaves in just the opposite manner or is negative to strong and positive to weak radiation. Owing to this variation of behavior with the radiation intensity, it is necessary to define the touch as that exhibited in strong radiation.

It is shown that the change of resistance in a receiver, in so far as concerns the molecular action, is due to the formation of an allotropic variety of the substance, which has a resistivity either more or less than that of the original substance. In some cases the radiation product or allotropic variety is stable and the change seems to be permanent. In other cases the radiation product is unstable and the substance returns more or less speedily to its pristine state. In either case, however, the return may be accelerated by mechanical tapping or jarring. The existence of the radiation product as an allotropic variety is stated to have been determined by independent means, at least in the case of silver. The two varieties of silver when powdered and made into receivers exhibit opposite behavior, the radiation product being negative, i. e., increasing in resistance in strong radiation, and the ordinary substance positive. The two substances made into a voltaic couple are said to give a potential difference of about one-eighth of a volt.

It is known that a receiver exposed to electric radiation may become fatigued and cease to respond to the waves passing over it. It has always been difficult to account for this fatigue satisfactorily. Prof. Bose takes the position that when waves impinge upon a sensitive substance they tend to form the radiation product or allotropic variety of that substance. If now the waves impinge upon the allotropic variety, they tend to convert it back into the original substance. Consequently when a sensitive substance is first exposed to electric radiation, the superficial molecules are converted slowly into the radiation product, accompanied by a certain observable change in resistance. After a certain time, however, the effect will be interfered with by the reconversion of a certain number of molecules from the radiation product into the original substance with the opposite tendency, and a time will be reached when further radiation will effect as much molecular change in one direction as in the other, or the substance will cease to respond unless renovated by heating, tapping or otherwise. Various curves are shown in the paper illustrating the conducting behavior of receivers of different substances under continued application of radiation, and in which these effects are manifested.

The general results of the inquiry are clearly to the effect that when an electromagnetic wave, or wave train, falls upon a substance, it produces two classes of effects. One is the absorption of energy into the surface of the substance in the form of heat, presumably by giving rise to vibration or agitation in the molecules of the body. The other is an alteration of the atomic structure within the molecules or on the surface of the body. The former is the grosser and more clearly manifested effect with which we are all so familiar, as in the case of radiant energy received upon the surface of the skin from the sun, or in the case of heat developed in a copper wire by the absorption of the electromagnetic waves which run along its surface when the wire gives passage to a current. The effects within the molecule are, however, evanescent, minute and relatively difficult to discover. They are the effects to which wireless telegraphy owes its possibility. These conditions may be roughly likened to changes produced on the seacoast by the action of the ocean waves. The larger disturbances or erosion and land sliding may be apparent to every observer from an elevated cliff on the shore, but every ripple that casts itself in sport upon the beach in the calmest weather produces small shiftings and disturbances in the sand which only a closer observation can discern.

Telephone Opposition in New York.

As presenting a view of the present telephone situation in New York from the standpoint of the company now occupying the field, the following will be found of interest:

In the course of his decision on the Washington telephone case, Justice Barnard referred to competing telephone systems, as follows:

"In Grand Rapids, Mich., and perhaps in some other cities where testimony was taken, there were rival companies causing competition, and where it was shown that nearly every subscriber had two telephones, one belonging to each company. The result in such cases is necessarily more inconvenient, confusing and expensive than to have only one company. * * * It would also be a misfortune to have two or more companies doing a general telephone business here. It would not only require two or more telephones in each subscriber's office where it was necessary for him to talk with the city generally, but the construction of conduits and lines would keep the streets torn up, and inconvenience the public much more than to have the lines all in the control of one company."

Judging from certain statements that have recently appeared in the daily papers, it would seem that New York is about to take its turn at gaining the experience which Justice Barnard says usually results so unfavorably. The Knickerbocker Telephone Company, the first of the various opposition telephone companies that have appeared in New York in the last few years to show any evidence of a serious intention to carry out published plans, has leased a building for central office purposes, has laid some underground cables, and states that in eight months or so it will have 10,000 subscribers in operation in New York City. A few years ago a system of 10,000 subscribers would have sounded rather large, but at the present day, when the Borough of Manhattan alone has over 40,000 telephones, and, at the current rate of increase, will have nearly 50,000 by the time announced for the starting of the Knickerbocker Company's system, a system of 10,000 subscribers in Greater New York would not cut a startling figure. A system of 10,000 telephone subscribers is to-day not a very large one, even taken by itself, and taken in relation to the area and population of Greater New York, it is almost insignificant. New York is made up of five boroughs, with a total area of nearly four hundred square miles, and a total population of over three million. How will the 10,000 new telephone stations be distributed? Presumably, it may be said, roughly in proportion to population, say 5000 in Manhattan, 4000 in Brooklyn and Queens and the remaining 1000 divided between the comparatively sparsely settled boroughs of the Bronx and Richmond. Telephone users in Manhattan, then, will have the option of being on a system with about 50,000 stations or on a system with about one-tenth of that number. The query naturally occurs: "Will the rates of the Knickerbocker Company be in proportion to this difference in the facilities offered?" The larger service will undoubtedly continue to attract the discerning portion of the public, those who want the most for their money. Where, then, will the Knickerbocker Company find its customers? In all probability these will be roughly divisible into two general classes. One of these will be mainly composed of those who are already users of the established service, for it has been the universal experience where competing telephone services have existed that many people take both services. The second probable division will be made up of that class of the community which is always the victim of the apparently cheap, when exploited with sufficient persistence and plausibility. The new system, then, may be expected to be made up of those who are already users of the existing telephone service, and will subscribe to the new as a matter of course—much as a wealthy man joins every new club, though he really uses only the one that his intimate friends frequent—and of a class that is ever attracted by the novel and the seemingly cheap, but which never originates business, attracts business, nor means business. Under these conditions the new service cannot be expected to be of great value to the community at large.

There are those that recognize all this, and think that the promoters of the enterprise appreciate it also, and that their real object is, after a demonstration in forces, to sell out to the New York Telephone Company. Even supposing that that familiar story would repeat itself in New York, it is doubtful to see wherein the subscribers of the Knickerbocker Company would benefit. Suppose the New York Telephone Company should take over the opposition system and simply carry out the contracts that the Knickerbocker Company had made with its subscribers, those subscribers would then find that they had bound themselves to pay for a term of years for a service of steadily diminishing value. The service would naturally diminish in value, since no effort would, of course, be made to increase the number of Knickerbocker stations, while a variety of natural causes would gradually remove them. It may be taken for granted that the New York Company, if it should acquire the Knickerbocker Company's system, would not change the enormous number of contracts with its own subscribers to conform to the terms established by the Knickerbocker Company. Therefore, anything in the nature of a real amalgamation of the two systems is in the last degree unlikely.

This being the case, it is worth while to consider the innovation introduced by the Knickerbocker Company of five-year contracts for telephone service. In telephone matters five years is a long time, and what is apparently cheap to-day may long before five years are over become most evidently dear. Suppose, for instance, that the New York Telephone Company had established the practice of making five-year contracts and had held its subscribers to them. The telephone service would be much dearer than it is to-day, and it would be far less valuable, as under such a practice the system would never have reached its present wide extension. The New York Telephone Company has, on the contrary, pursued a most liberal policy towards its customers, as not only are its contracts annual, and terminable after the first year at short notice, but it has invariably, on the introduction of any rate modification, offered the advantage of the new rates to all existing subscribers. In the past five years the rates have been reduced several times, and the present minimum rate is actually 60 per cent. less than the first minimum rate established under the message rate schedule only a little over five years ago. The possible effects then of five-year contracts may easily be gauged. Further, it is quite evident that the liberal policy adopted by the New York Company in dealing with its customers could scarcely be adopted by a company whose ultimate purpose was to sell out its system and good-will.

The success of the Knickerbocker Telephone Company in its canvass for telephone subscribers is very fair, judging by the figures that have been published, but considering the area and population of the City of New York it is by no means so great as to show that there is any widespread demand for a new telephone service. The few points noted above by no means cover an exhaustive consideration of the question of competing telephone services in the same city, but they indicate some of the standards by which any disinterested observer may weigh the advantages and disadvantages of the situation.

Metropolitan Plans for the Third Avenue Road.

A meeting of the stockholders of the Third Avenue Railroad Company, New York City, was held on March 21, at which was elected a new board of directors, representing both the old and new interests, the new board afterwards electing H. H. Vreeland president *pro tempore* and Henry Hart vice-president. A plan for the funding of the Third Avenue Company's debt was practically agreed upon. It is as follows:

For the total amount of the debts, floating and funded, which the standing Master in Chancery reports to the United States Circuit Court, the directors of the Third Avenue Railroad Company will authorize an issue of bonds. These bonds will be to an amount sufficient to pay off both the funded and floating debt of the road and they will be secured by a first mortgage on the property. The present first mortgage bonds and the second mortgage income bonds will be redeemed with this new issue and the mortgages cancelled.

The majority stockholders, the Metropolitan Street Railway, were represented by William C. Whitney, Thomas F. Ryan and Herbert H. Vreeland. The minority stockholders were represented by Henry Hart, Edward Lauterbach, Albert J. Elias, Charles Remsen and Henry Iden. This board was elected: Herbert H. Vreeland, Henry Hart, William C. Whitney, Edward Lauterbach, Thomas F. Ryan, Albert J. Elias, John D. Crimmins, Henry Iden, Grant B. Schley, Charles Remsen, Walter S. Johnston, Samuel Riker and Edward M. Burghard.

The Polyphase Distributing System of the Metropolitan Street Railway Company of New York City—I.

BY J. E. WOODBRIDGE.

INTRODUCTORY.

THE whole trend of development of the generation of electrical power from steam engines has, during the last few years, wherever possible, been toward the concentration of the generating machinery for widely distributed loads in central power plants which turn out polyphase alternating currents at high pressures, these currents being distributed over considerable distances to substations in which they are transformed down, converted into other forms and redistributed over local areas. A unique feature of this tendency is that it renders exactly the same type of central generating and distributing arrangements suitable for traction work, for lighting and for power distribution by means of motors; electrical transforming and converting machinery having reached such a state that all services are readily supplied from the same circuits.

During the last three years work has been started on a number of systems of this kind, each far surpassing in magnitude any electrical installation hitherto constructed the world over. The first to approach completion is that of the Metropolitan Street Railway Company in New York City. On account both of its magnitude and of the inability of many commonly used arrangements and details to meet the requirements imposed by this magnitude, there was involved in the design of its electrical section much original work, in consequence of which the installation represents a notable step forward in electrical engineering. For this reason its many unusual features will be described with considerable detail in these columns in a series of articles under the heading given above.

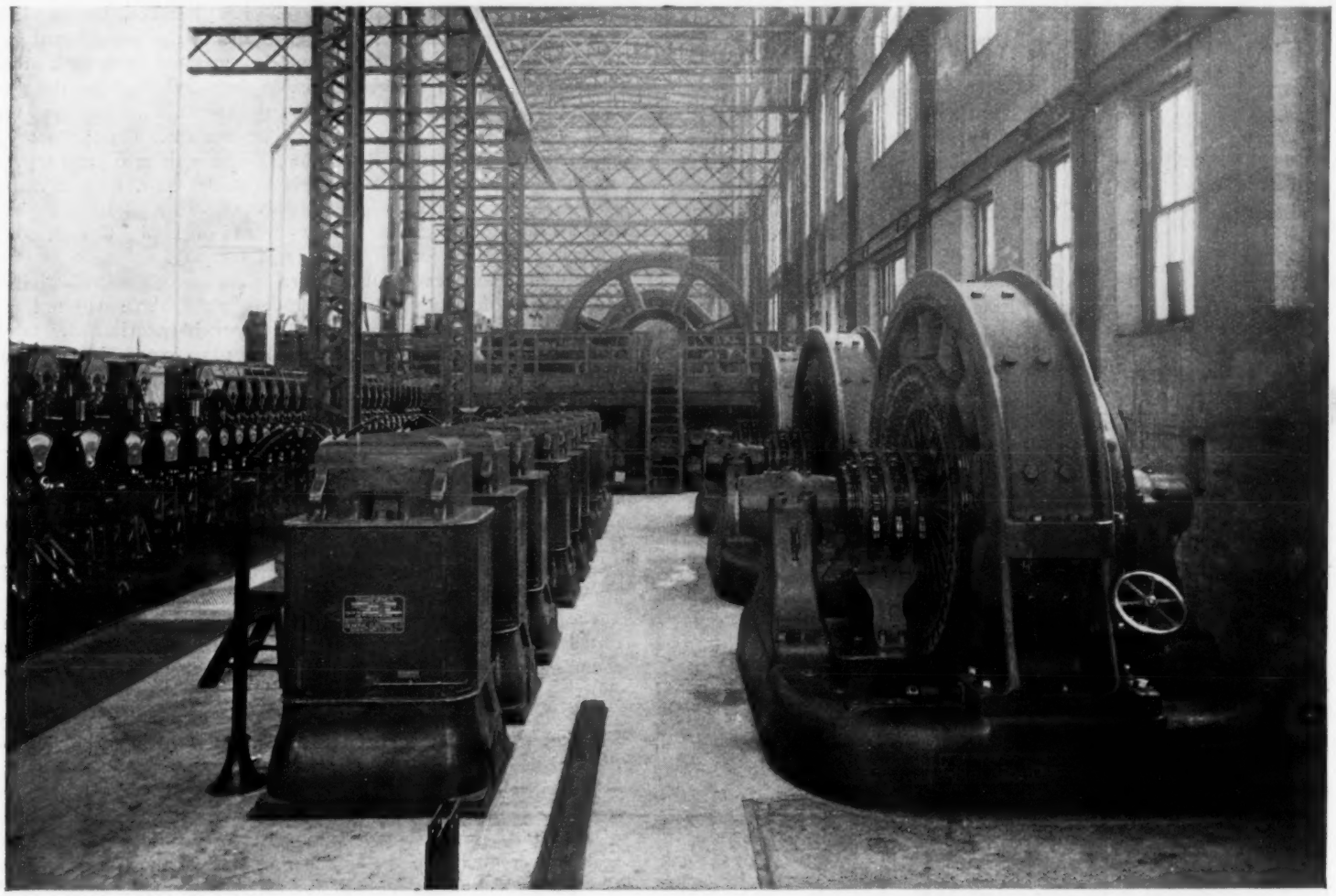

FIG. 1.—VIEW OF THE 146TH STREET ROTARY SUBSTATION, SHOWING THE TEMPORARY STEAM PLANT IN THE BACKGROUND.

THE PURPOSE OF THE SYSTEM.

Before taking up the details of this great work it might be well to outline the traction situation in the territory occupied by the lines of this company and to show the needs which the installation described below will have to meet.

The Metropolitan Street Railway Company operates in lesser New York, its lines running from end to end and from side to side of Manhattan Island, covering an area about ten miles long by two miles wide. The lines owned, leased or operated by the Metropolitan Company aggregate about 217 miles of track, operated partly by underground trolleys, partly by cable and partly by horse. The length of track at present operated electrically is 82 miles, including most of the heavily traveled up and downtown lines. The cable system, aggregating 25 miles of track, which includes the famous Broadway cable line, will, with a part of the trackage now operated by horses, be changed to accommodate electric cars during the present year. The total number of electric cars (open and closed) at present owned by the company is about 1500, in addition to which there are about 600 cable cars for the cable lines which will soon be refitted for electric service. There is shown in Fig. 2 a map of these lines, showing the location of the main power station and the rotary-converter substations at present proposed.

During the last few days the Whitney syndicate, which controls the Metropolitan Company, has obtained a controlling interest in the Third Avenue Railroad Company, which has in the same territory as that shown on the map about 58 miles of track, either in operation on the open-conduit electric system or with conduits for this purpose under construction. This will be operated with power from the same generating station and will add about 600 cars to the total number. With this acquisition comes that of the Union Railway Company, operating 55 miles of track in the upper part of the city with about 200 electric cars, on the overhead trolley system. As the generating equipment of this road is somewhat out of date, power from the new polyphase plant will probably be used for it also. Altogether the lines which will be operated from this station within a year will have in round numbers 3000 cars in their stables, which will probably give about 1500 in actual operation at one time.

Independent of the Metropolitan Company the only urban transit system remaining in Manhattan Island is the elevated road, which will be electrically operated from its own power station now under way. Later the underground rapid transit road will require a large amount of power, and if, as is possible, this road is operated by the

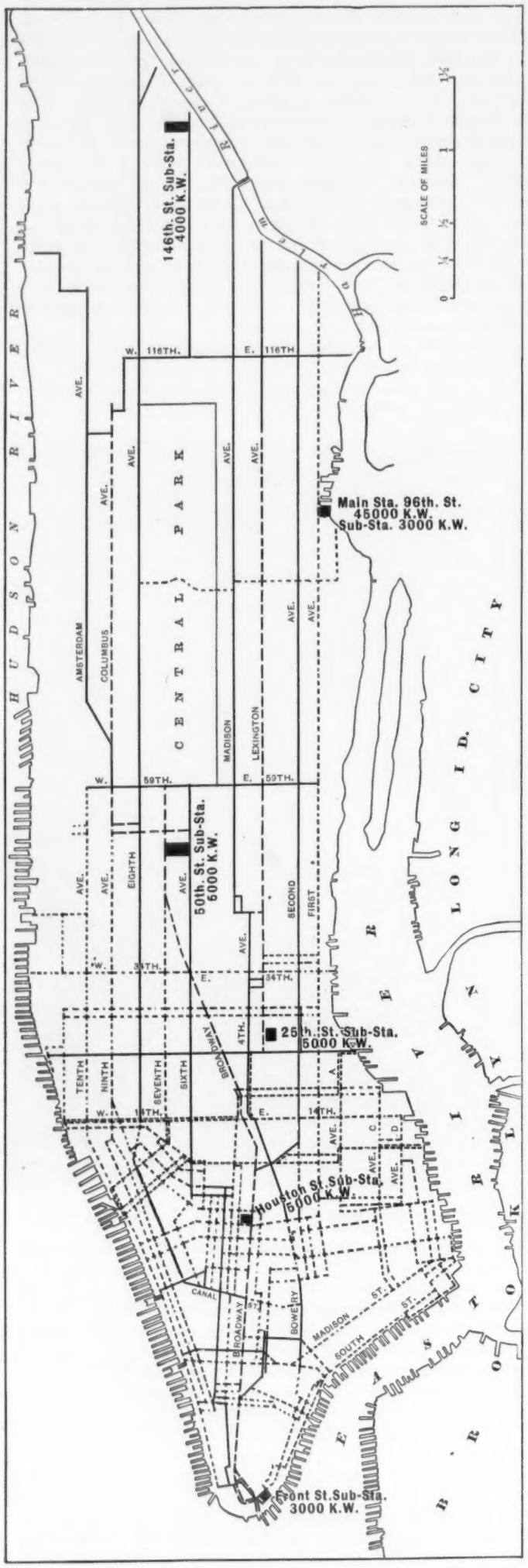

Fig. 2.—Map of the Metropolitan Street Railway System, Exclusive of the Third Avenue and Union Railways Recently Acquired, Showing Locations of Power House and Substations. Electric Lines Shown Full, Cable Lines Dashed and Horse Car Lines Dotted.

Metropolitan Company, even the mammoth station here described may come to be insufficient for the work of the company. There is no provision for extensions of this station, which occupies in its present size a whole city square.

The gross income of the Metropolitan Company amounts at present to about $15,000,000 per annum; that of the Third Avenue and Union Railways to about $3,000,000 more.

THE PROVISION AGAINST DANGERS OF POWER CONCENTRATION.

The central generating plant will contain, when completed, eleven main engines, each rated at 4500-hp at the cut-off of maximum economy, and capable of working up to some 7000 or 7500-hp apiece. The designers of the electrical section appreciated the risks that would accrue were this tremendous power at high voltage—6000 to 6600 volts—allowed to concentrate itself on a single fault. On account of this and the widespread character of the public service which would be interrupted by the shut-down of such a large street railway system, all routes via which the power is carried from part to part of the station, as well as from it to the substations, are subdivided as far as possible, so that the station is virtually as safe as a number of widely separated generating plants, so far as danger from concentration of an extremely large amount of power or danger of a complete shut-down is concerned. For instance, the conduits which carry the cables from the generators to the switchboard galleries are several in number and widely separated from each other. The same is true of the vertical cable shafts which carry the generator leads from the conduits up to the switchboard galleries, and the feeders down again to the outgoing conduits. On this account the spread of a burn out—as may be possible with such great powers—until it destroys a whole conduit or cable shaft, will only shut down a part of the system instead of the whole, as would be the case were all the circuits carried at any point in proximity to each other, as through a single conduit, shaft or passageway.

For well-known reasons it is desirable not to continue this division and isolation of the power units throughout the whole station, but is preferable to connect everything to one switchboard in order to obtain flexibility and concentration of all loads when desired. Otherwise there is nothing gained electrically by the use of one large station in the place of several smaller ones. On this account the generators are in this case all wired to and handled on one switchboard, but it is noticeable that even here similar precautionary measures have been taken against trouble due to concentration of large powers, by distributing the switching apparatus itself over a much greater area than would for purely mechanical reasons be necessary, and by isolating each switch and even each pole of each switch within its own cell separated by brick walls from the other cells and by double brick walls and intervening air spaces from other switches.

The only point at which all the power may be actually concentrated is the busbars themselves, and these are protected by a surrounding and isolating structure, rendering them almost absolutely short-circuit proof.

Recollecting this dominant idea in the layout of the electrical system the reason for many of the details described in succeeding sections of their treatise will be apparent.

The novel features of many of these details and the ingenious solutions of many new problems which have arisen in the working out of a complete polyphase rotary-converter proposition on such a large scale are creditable to the engineering staff of the General Electric Company which designed, built and supplied all of the apparatus, descriptions of which will appear in continuations of this article.

Industrial Exhibition.

A bill was introduced recently in the New York Assembly at Albany for the purpose of incorporating the Industrial and Exhibition Company of New York for the purpose of holding industrial and commercial exhibitions. The capital stock of the company is to be $5,000,000 and the company may issue mortgages on its property and property rights to the amount of $20,000,000. It is proposed to erect buildings having a total floor space of not less than 2,000,000 square feet. The city is authorized to enter into a contract to rent floor space for an exhibit and to appropriate $100,000 for prizes. The corporation is to set aside 200,000 square feet of floor space for rental by the state. The Governor is to appoint eight state commissioners, the Mayor of New York City eight commissioners, and the company sixteen, who are to constitute a Board of Exhibition Commissioners.

The County of London Electric Lighting Company.

THE County of London Electric Lighting Company was formed in 1890 and by 1898 franchises had been obtained by the company for eleven of the forty-five London districts, and at the present date work in seven of these districts has been completed. The plans of the engineer and manager of the company, Mr. A. J. Lawson, provided for the supply of all the districts on the north side of the river from one station at City Road, and for all districts to the south of the Thames from the station at Wandsworth, until such time as the company might be required to provide for a separate station in the parish of Camberwell, when it was intended that both the Wandsworth and Camberwell stations should be interconnected and run in parallel during the winter at times of maximum load, but that each station should be shut down during part of the summer in order to undergo a complete overhauling before the recommencement of supply in the autumn.

CITY ROAD STATION AND SYSTEM OF DISTRIBUTION IN THE NORTHERN DISTRICTS.

In the latter part of 1894 premises formerly used as a coal wharf were secured as a site for a generating station, but it was not until the beginning of 1897 that the building work was completed nor until September of the same year that a supply was available from the company's own plant, although current had been given to consumers from the company's mains by arrangements with a neighboring company for nearly two years prior to that date. The site of the station is 303 feet 6 inches along the canal basin of the Regent Canal Company, 165 feet along Graham Street parallel to the canal, 140 feet from the canal to Graham Street at the northern end, and, being cut diagonally by City Road at the south end, the length along City Road to Graham Street is 198 feet 9 inches.

It was decided to construct the buildings within what is practically a water-tight tank, formed by thick concrete foundations overlying the whole area of the land, and with water and moisture-proof walls towards the canal, along which a coffer dam had to be placed by the builders.

Buildings.—The buildings are constructed throughout of selected stock bricks and Portland cement, and the general design, so far as at present finished, is shown in Fig. 1. The chimney is a massive structure in section of a square form with the corners cut off, both internally and externally, and is 200 feet in height, with an internal diameter at the top between the parallel sides of 12 feet.

The boiler room is a two-floored building with mezzanine floor for a short distance at one end, occupied as described later on. The interior of the engine room is lined with glazed bricks and the floor tiled over with "Adamant" tiles, thus securing one of the greatest desiderata in engine rooms of generating stations—cleanliness. The switchboard room off the engine room is also similarly lined with glazed bricks and has a tiled floor. All floors throughout the building are of concrete on iron joists, the only woodwork being that used for doors and door posts, wood block floors laid over the concrete, and the boarding for carrying the slates over the engine room roof.

Boiler Room.—The boiler room was placed along the canal and is a room 198 feet 3 inches in length by 41 feet 4 inches in breadth, with space at one end for a double set of Green economizers and gearing, above which there is a short length of flooring upon which the feed pumps are placed. From this to the present extreme north end of the building there are now installed two batteries of six boilers each of Babcock & Wilcox make, with room for a third battery of five boilers. These are fired automatically by Vicars' stokers, the hoppers of which are supplied with coal through vertical tubes from the coal store above. These stokers have hitherto been driven by two engines, but in order to avoid the loss by condensation in long lengths of steam pipe, it has recently been decided to replace at least one by a small motor, to be supplied off the direct-current mains. The floor is some two feet above the level of water in the canal basin, and the ash and clinker is wheeled out into steel barges belonging to the company, which are alternately used for carting away the ashes and bringing up coal from the lower reaches of the river. Between the boiler fronts and the wall along the canal there is sufficient length and no more for the withdrawal of tubes from the boilers.

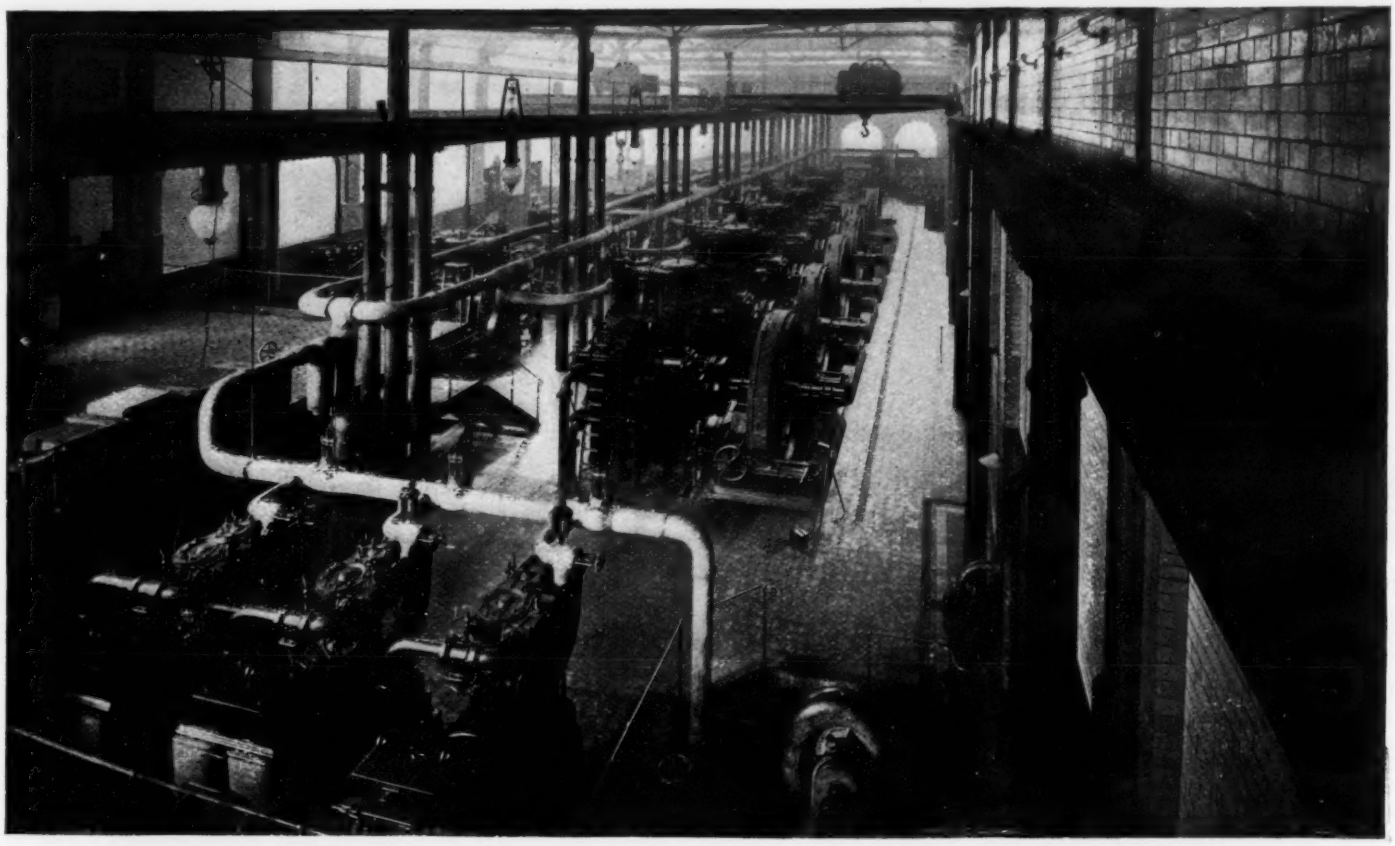

FIG. 1.—ST. LUKE'S STATION. SINGLE-PHASE MACHINES ON LEFT, TWO-PHASE MACHINES ON RIGHT.

Feed Pumps, Tanks, Etc.—On the pump room floor, which is just on a level with the roadway leading off the abutments of the City Road bridge, are placed two steam feed pumps, as well as two feed pumps driven by electric motors off the direct-current mains, each capable of supplying 4000 gallons or more per hour against 150 lbs. pressure. On the same floor there is a large hot water tank, into which the condensed steam from the engines is returned, and where it is freed as much as possible from any cylinder oil which may

come along with it, while underneath in the feeder ring mains are two oil filters similar to those generally used on ocean steamers.

Coal Storage and Handling.—In order to deal with the large amount of coal per annum which is consumed, and to provide sufficient storage accommodation coal bunkers have been built over the boiler room throughout its whole length. These bunkers are divided longitudinally by a passage way along which rails are laid, upon which rails an automatic recording weighing machine runs. This machine, which was specially designed by the company's late engineer, is so constructed that all coal, even the smallest, must be discharged on each opening of the door, and it automatically records the number of times which the door has been opened, and this record must correspond with the number of printed tickets of weight handed in by the trimmer at the end of each eight hours' shift. Into the bunkers on each side (which are divided transversely by steel plate bulkheads) the coal is conveyed by an automatic conveyor fed from barges. This apparatus is capable of dealing with 35 to 40 tons of coal per hour, and the whole of the labor required to work it consists of two laborers in the barge below to trim the coal into a heap for the grab as the barge is nearly emptied; one man to work the crane, and part of the ordinary trimmer's time in opening or closing the shoot doors of the conveyor as the bunkers are filled. Including steam, water and labor, but not including interest or depreciation on the cost of the appliances used, the cost of handling is approximately one penny per ton from the barge into the bunkers. The coal bunkers are capable of containing about 1000 tons.

FIG. 2.—SWITCH ROOM, ST. LUKE'S STATION.

Engine Room.—The engine room, which lies behind the boiler room from the canal, is 60 feet in width, with an average length of 180 feet, and is provided with a row of pillars along the center, supporting the roof and the girders, carrying two 20-ton cranes (not electrically driven), which convey any piece of machinery to or from the landing stage to its appointed place in the engine room. Owing to the peculiar shape of the land, by the diagonal cutting off of the southern end, it was found impossible to utilize the whole space for generating sets, and it was decided to put two landing stages on the road level, the floor of the engine room itself being at the same level as the floor of the stoke room.

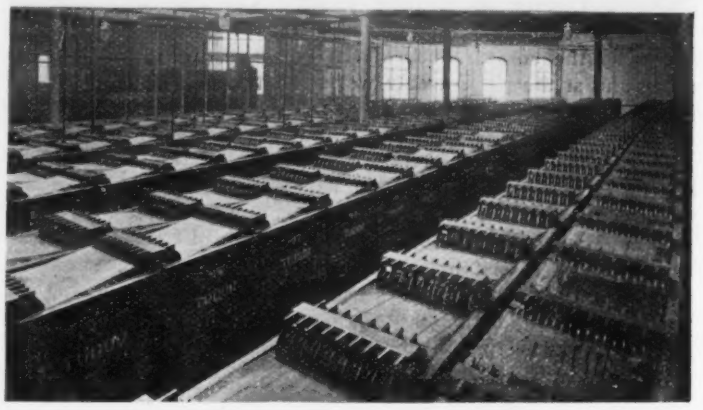

FIG. 4.—STORAGE BATTERY ROOM, ST. LUKE'S STATION.

Engine Room Machinery.—On the right-hand side on entering there are two centrifugal pumps driven by steam engines and one motor-driven centrifugal pump for supplying circulating water, which is drawn from the canal at the southern end of the building and discharged at the northern end. To the left of these pumps and close by one of the landing stages are three steam driven exciters. Further along on the same side there are six 200-kw two-phase 50-cycle generators, built by the Electric Construction Company, of Wolverhampton, and space for a motor generator bi-phase and single-phase, the purpose of which will appear hereafter. On the other side there are five single-phase alternators of the Brush Company's make and of Mordey's well-known design of 180-kw each These were originally supplied as 150-kw machines, but it was found that, owing to improvements in design, they could be safely loaded to 90 amperes at 2000 volts. The whole of the engines for the circulating pumps, exciters and main generators were made and supplied by the Brush Electrical Engineering Company, and are

FIG. 3.—ST. LUKE'S STATION.

of the cross-compound marine type, with Raworth's patent flywheel governor fitted with attachments for speeding up or down the engines

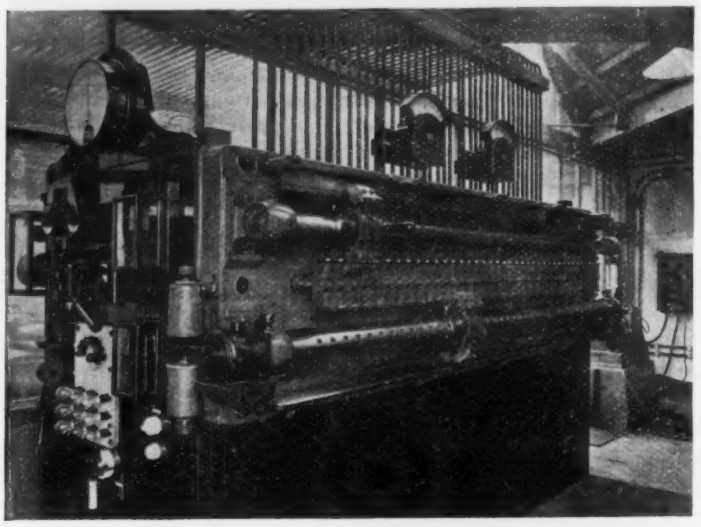

FIG. 5.—STORAGE BATTERY REGULATOR, ST. LUKE'S STATION.

when running, so as to ensure easy synchronizing and an even distribution of load between the various sets when run in parallel.

Motor-Generator for Phase-changing.—The Brush Company's machines are run in parallel, and the Electric Construction Company's being of different periodicity, are also run by themselves. To ensure economy in working until all machines are converted to two-phase machines of 50 cycles periodicity instead of 100 cycles, as at present, the company's late chief engineer arranged to place a motor-generator in the space between the Electric Construction Co.'s main generat- ors and the exciters, the function of which is to generate either as a single-phase 2000-2200- volt 100-cycles machine or as a two-phase 2000- 2200-volt 50-cycles machine, according as a two-phase or single- phase steam generator may be at work at time of light load, thus providing for the running of one engine instead of two, while giving a single-phase supply to the older parts of the district and a two- phase supply to later connected districts where mains have been laid.

Direct-Current Power Sets.—At the far end of the engine room are two cross-compound engines of Messrs. E. P. Allis & Co.'s make, direct-coupled to 550-kw generators of the General Electric Company of America's manufacture, supplied by the British Thomson-Houston Company. The circulating water for the condensers is provided by the same pumps which supply circulating water to the other engines, but the condensers are separate from the engines and are fixed in the basement, the air pumps being three-throw electrically-driven pumps of Blake, Knowles & Company's make. The condensed water is raised into the pipes supplying the feed tanks at the south end of the boiler room building by means of small three-throw pumps, also driven by motors. On the switch room side of the building there are also two alternating, single-phase motor-generators, coupled to two 75-kw 530-volt direct-current machines, which have hitherto supplied the direct-current for motors throughout the Clerkenwell and St. Luke's districts. There is also a two-phase 50-cycle motor-generator direct-coupled to a direct-current machine of similar voltage and output.

The small size of generating units at the City Road station is due to these units having been ordered as long ago as 1894, when it was the intention of the company to have two stations instead of one. On the appointment of Mr. A. J. Lawson as engineer, he arranged to erect one station only, but the order for the apparatus having already been given, larger sets could not be substituted.

Steam Pipes.—These form a ring in the boiler room and a ring on each side of the central pillars in the engine room and are cross-fed by pipes underneath the floor, so as to have a clear way for any machinery carried by the cranes. All these pipes are fitted with section valves in the main rings, so as to have as small a length of steam pipe alive at one time as possible, and the valves for the engines are placed close up to the main steam pipe, so that in shutting down the engine the length of pipe between the main pipe and the engine is also shut off and condensation lessened. The steam valves throughout are parallel side ones of Messrs. Hopkinson's make. A non-return valve is inserted in each boiler steam pipe.

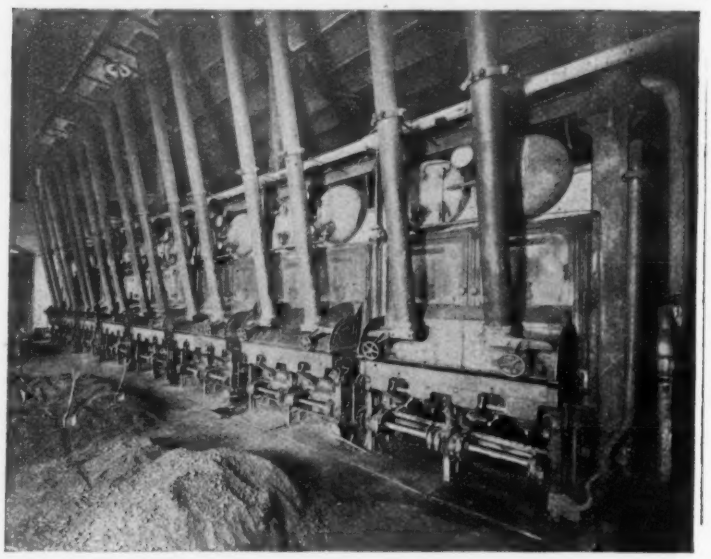

FIG. 7.—BOILER ROOM, WANDSWORTH STATION.

Condensers and Air Pumps.—The exhaust pipes are fitted with automatic valves, so that engines may either exhaust to atmosphere or through the condensers. The latter are fitted in the back

FIG. 6.—WANDSWORTH STATION.

standards of the engines driving the alternators, each engine being provided with its own air pump, driven by means of a lever off the low-pressure crosshead. Although the speed of these engines is 215 revolutions, a satisfactory vacuum is obtained. The condensed steam is returned by means of a small drum pump worked by a chain and sprocket wheels on pump and main shaft, it having been found that the force pumps, which were also driven along with the air pumps, ran at too high a speed to deal with the whole of the condensed water. Condensing water is taken from the canal.

Exhaust Pipe.—The engines are connected for running to atmosphere with a main exhaust pipe, which runs along underneath the floor on either side of the building and thence to the stoke room floor, where it is joined into one main pipe, which continues to the top of the chimney, a height of some 200 feet from the ground level.

Switchboards.—Within the engine room is erected the switching appliances, made by E. F. Moy & Co., for dealing with the exciting current from the main exciters and from the exciting battery, which was installed in order to ensure absolute evenness of pressure. These panels deal with the currents from the three main exciters, with the connections of two small self-exciters attached to two Brush machines, and with the main current to and from the exciting battery. At the other end of the building there are two switchboards for the railway generators, of the General Electric Company of America's standard make, with panels for two more sets (should sufficient demand arise), for further machines of the same make. For such machines space is available between the direct-current machines and the present alternating current machines on both sides of the engine room. These latter switchboards are connected by cables to the distributing power switchboard, to which are also connected three switch panels, made by the Electric Construction Company, of Wolverhampton, to control the motor-generators, which may be operated either as direct-current machines, taking direct current and supplying alternating current to the mains, or vice versa. Between these machines switch panels and the circuit panels there is a main measuring board upon which are mounted ammeters and two Thomson integrating wattmeters for light and heavy load, a recording ammeter and recording voltmeter. Beyond this latter board are ten circuit panels, of Ferranti's make, originally intended for alternating current circuits, but now adapted for control of the power mains, which will be later described.

Alternating Current Switchboards.—In the view to the left of the switchboard room are shown the main alternator switchboards, both consisting of twelve switch panels, and between them the main measuring board, upon which are mounted two sets of measuring machines, one for light and one for heavy current. At present the board shown on the left is a single-phase board, while that to the right is a two-phase board. On the right-hand side of the dividing board there are at present placed two instruments for recording the output of each side of the two-phase plant, while on the other side are the two sets of instruments for measuring and recording the output of the heavy and light load of the single-phase plant; but so soon as all the plant has been changed over to two-phase both sides can be altered so that they measure and record the outputs of both phases at light and heavy loads respectively. To the left of the main switchboards there are two switchboards of twelve panels each for the single-phase distributing mains, supplying respectively Clerkenwell and St. Luke's; and further on, right in the corner of the room, is a six-panel board, now used for connecting up the single-phase motor-generators to the circuit, which later is intended for use in connecting up the two-phase motor-generators, when the complete change over to two-phase working is made. On the right of the alternator switchboard there are at present twelve panels for the two-phase mains, which supply current to the districts of Western Holborn and St.

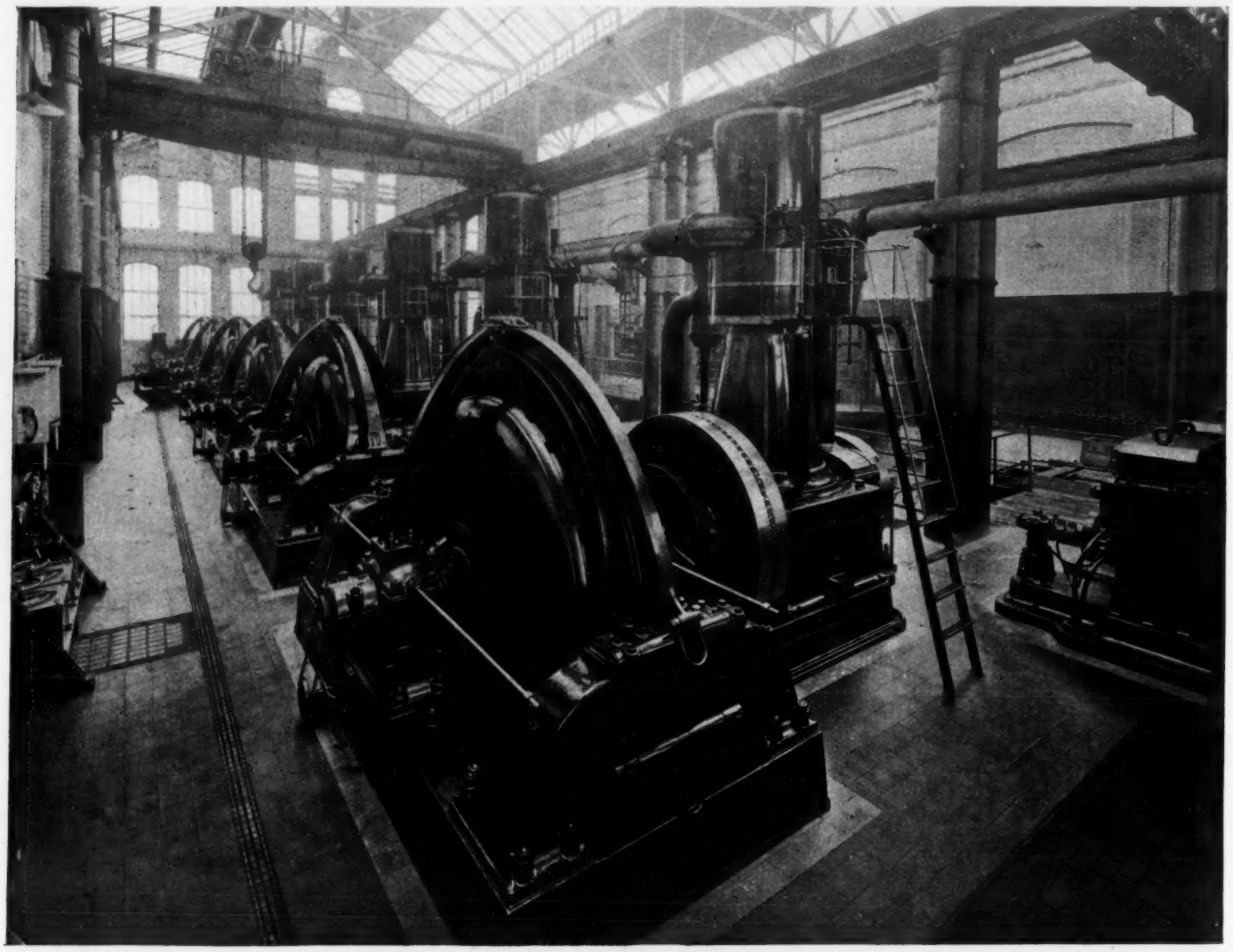

FIG. 8.—GENERATING ROOM, WANDSWORTH STATION.

ENGINEERING SOCIETY LIBRARY, UNIVERSITY OF MICHIGAN

Giles. There is also room for two other sets of panels of twelve each, one of which was intended for the mains for supply of the East End districts, and the other for any further increase of the power mains or for further alternator switch panels if required.

Regulation.—Underneath each of the alternator switchboards are seen the handles regulating the resistance in series with the field windings of the main machines, in connection with which there is also an ammeter in each circuit. The regulation of the general voltage of the station is controlled by resistances placed on the regulating table, shown in the front of the main measuring board,

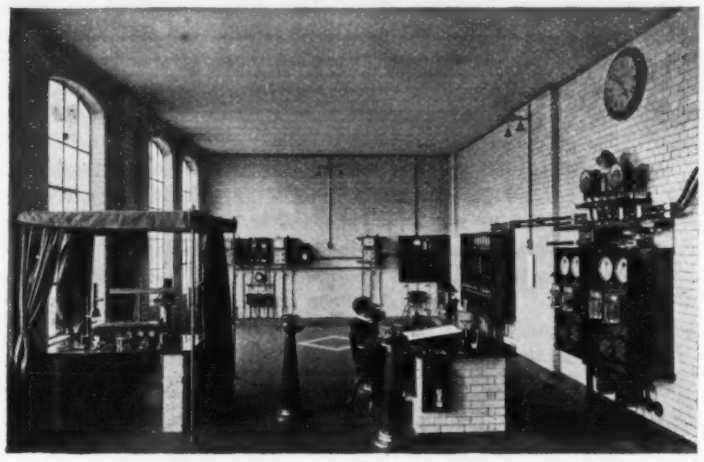

FIG. 9.—SWITCH ROOM, WANDSWORTH STATION.

and auxiliary regulation is provided by the switch pillars, shown to right and left of the table and in the rear of the switch attendant's table. The whole of these switchboards, with the exception of those specificially mentioned, have been supplied by Messrs. S. Z. de Ferranti & Co.

Testing Instruments.—A very fine set of testing instruments for insulation, measurements, etc., has been provided by Messrs. Elliott Bros., and is similar in all respects to the set at Wandsworth, shown in the illustration of the switch room at that station.

generators during the day or by itself at night, for the supply of current to motors which may be then running in printing establishments, etc. On the same floor there is also a booster or motor-generator to raise the voltage sufficiently for charging, as well as a small milker for any cells which may fall "out of condition." Both these machines were supplied by the Electric Construction Company, of Wolverhampton.

Battery Switchboards.—The battery switchboard, on which are double sets of terminals for charging and discharging, is also provided with an automatic motor-driven arrangement for throwing in or on cells, according as the voltage on the main lines falls or rises below the normal. This switchboard, the invention of Signor Enrico, was supplied by Professor Mengarini, of Rome, who also uses similar switchboards in connection with the Rome-Tivoli installation and distribution of current to the Roman Tramways Company.

System of Distribution.—In the original contracts which were entered into with the Brush Company and the Electric Construction Company in the early part of 1894, high periodicity plant alone was provided for, and in order to obtain the consent of the Board of Trade to a change from the system originally inserted in the Clerkenwell order, viz., the direct-current system (the London Electric Company having an order for the supply of alternating current in the district), the company had to agree to supply continuous currents at 530 volts in both the Clerkenwell and St. Luke's Districts for motive power. Difficulties were also raised by the County Council as to the construction of transformer boxes under the streets, but the local authorities of St. Luke's and Clerkenwell having consented to the placing of such boxes in the streets, it was finally decided after submission of the question to the Board of Trade that they should be allowed and that they were to be of such construction as to preclude the possibility of gas entering the boxes, or, if it did enter, the construction was to be such that by no possiblity could it remain there and cause an explosive mixture, which might be ignited by spark from the blowing of a fuse or other accidental interruption of circuit within the boxes.

Transformer Boxes.—A specially ventilated form of box was thus rendered necessary, and such a box, the invention of the chief engineer of the company, was finally approved by the Board of Trade. The sites of the boxes north of the Thames had to be finally settled

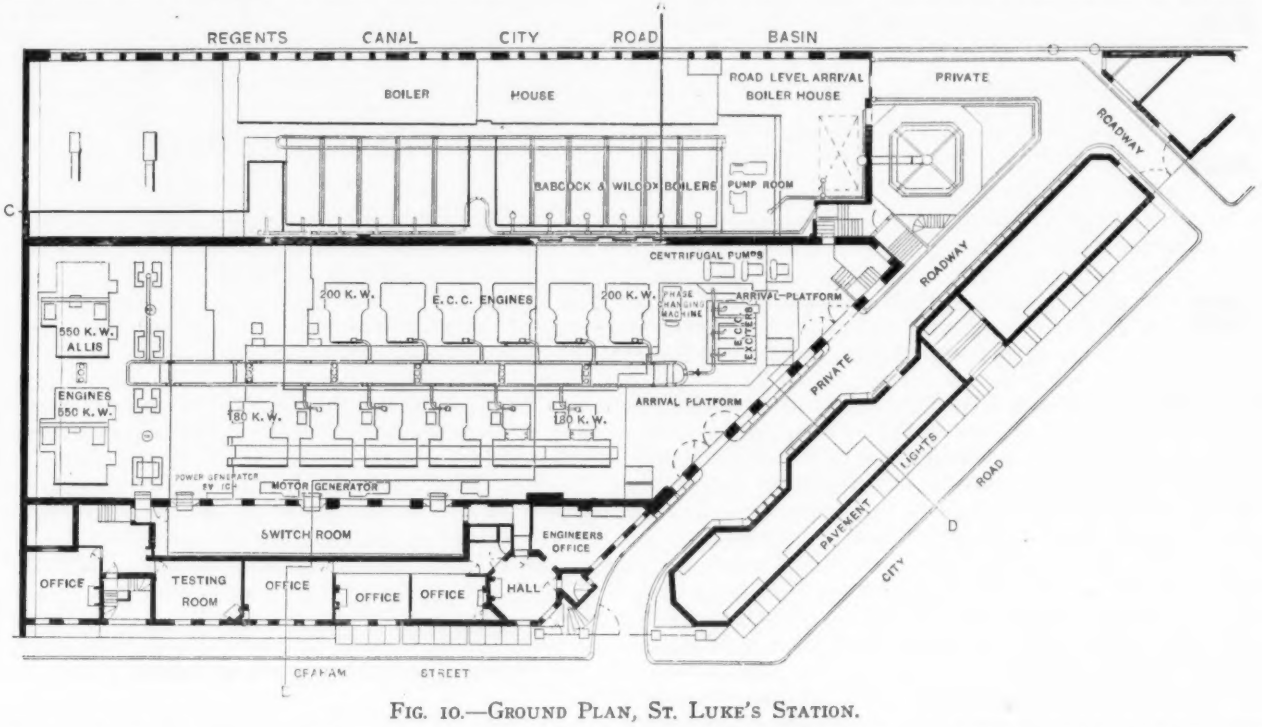

FIG. 10.—GROUND PLAN, ST. LUKE'S STATION.

Repair Shops.—In the basement underneath the roadway, between the main building and the offices at City Road, and underneath those offices, is a workshop, provided with some of the latest repairing tools, such as lathes, drills, shapers, etc., driven by an electric motor.

Storage Battery.—In a room above the landing platforms at the southern end of the building there is provided a battery of 302 Tudor storage cells, having a capacity of 595 kilowatt-hours, which is run in parallel with the motor-generators or some of the railway

by Major Cardew, the Board of Trade electrical adviser, while those on the southern side of the Thames were agreed with the local authorities. The transformer boxes themselves, which at one time occupied a space 5 feet 6 inches in width by 5 feet in length and 7 feet 6 inches in depth, have now been made to take up a much less width under the footpath, though occupying a somewhat greater length.

Mains.—The draw-in system was finally decided upon by the company, and cast-iron pipes of 2 or 2½ inches diameter were laid throughout the whole district, the smaller sized pipe being used for

the high tension mains, while the larger pipes were to be used for the low tension and power mains. A sufficient number of pipes was also laid in on all the routes to provide for duplicate high tension mains and for feeders from transformer boxes to various points along the routes of the low tension mains. A separate pipe of similar size was also provided for mains for public lighting, which it was originally proposed by the engineer should be carried out by means of alternating arc lamps and pillar transformers, as had been done at Dover under his plans; but subsequently, on the completion of the continuous-current system for power supply to the district, he arranged for the supply of such lamps in groups of ten each from the direct-current mains, such groups to be switched on or off at feeding points, as might be found convenient.

Cables.—For alternating current high-tension supply the cables used in the districts on the north of the Thames are paper insulated, lead-covered, concentric two-conductor cables, of the British Insulated Wire Company's make, while for power supply rubber insulated, two-conductor concentric cables of the Silvertown Company's make have been used throughout. For the low-tension distribution, which is at 100 volts, Callender jute and bitumen insulated two-conductor

pany, has been provided. By the arrangement of these switches it is impossible to open the low-tension circuit without having first opened the high-tension one; also, the inner on both circuits is opened before the outer, and in closing the circuits the outer conductor of the low circuit and then the inner has first to be closed and then the outer and inner of the high-tension circuit. Subsequent improvements, tending to simplification of the switching arrangements have been introduced by Mr. Lawson, Mr. Gosling and Mr. Dallas, and are embodied in a patent covering a modified form of transformer box and its equipment.

In Western Holborn and St. Giles the whole of the mains have been laid for a two-phase alternating system of distribution, for both lighting and power, and to these mains current is supplied at a pressure on either phase of 100 volts; if one be fully loaded and the other unloaded, the difference is not more than 2½ per cent. When the whole change to 50 ~ two-phase supply is made, it is proposed to balance up the single-phase distribution mains on the switchboards at the stations so that the load may be as evenly divided as possible between the two phases, St. Luke's being on one phase and Clerkenwell on the other, while the outlying districts shall be two-phase, the

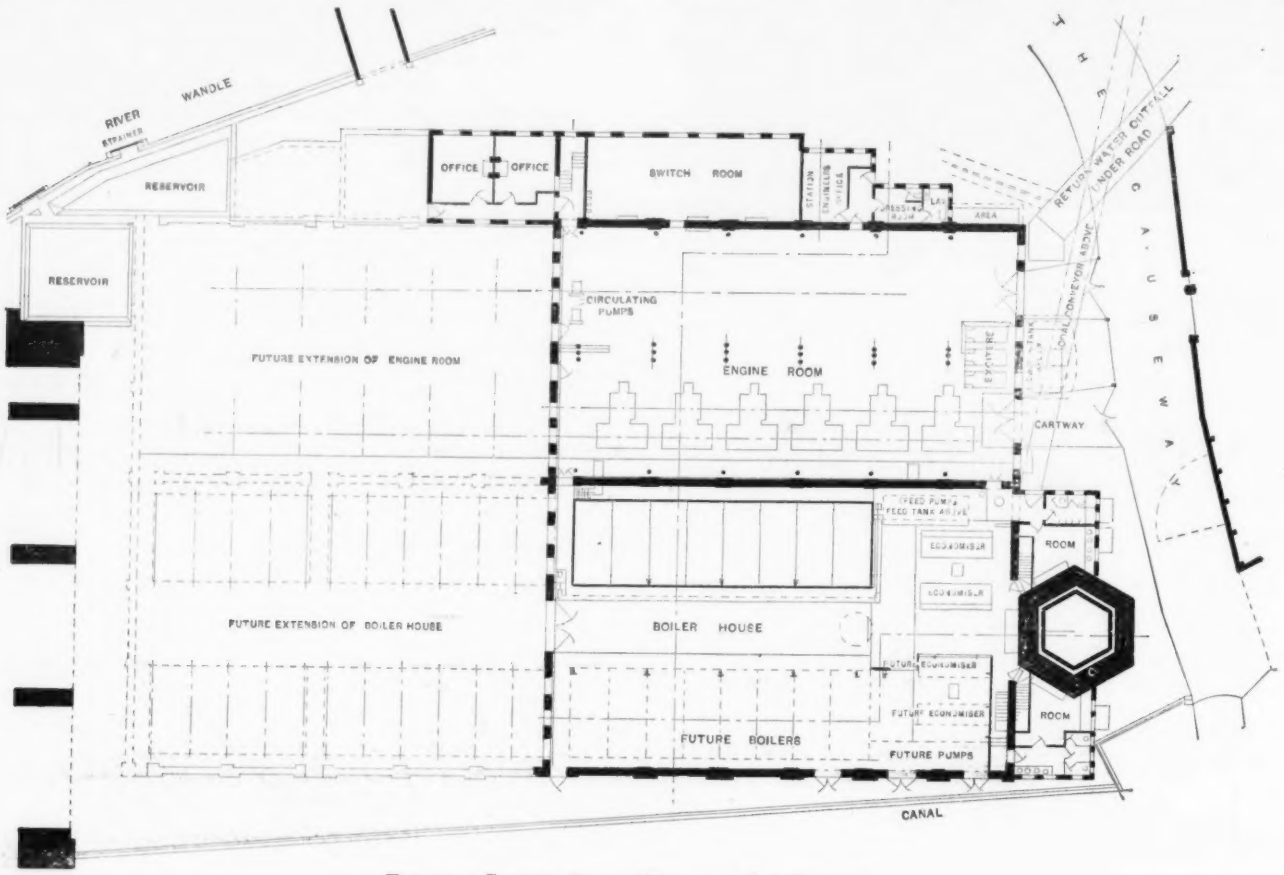

FIG. 11.—GROUND PLAN, WANDSWORTH STATION.

lead covered cables are used. On the latter cables, two-way house service boxes are provided at the rate of one to every four houses, the outer wire in each having a connecting link or fuse in the street service box, so that in case of necessity any house may be disconnected from the supply mains without entering the premises. In the case of supply for motive power, the service cable is vulcanized on to the rubber insulated main, and this service cable is carried into a special service box within the consumer's premises, the joint invention of Mr. Lawson, Mr. Dallas and Mr. Childs. From this box two separate mains are carried to the motors through the usual starting and circuit breaking appliances.

System of Distribution.—In the system of distribution from the transformer boxes, each of which is limited for supply at low pressure to 75-kw output, there is always a master box, to which the feeder from the station is laid, and between this master box and some other, or between some of the other boxes on each circuit an extra cable is laid, so that a complete ring system practically prevails throughout the whole of the districts, thus enabling any one box to be made absolutely "dead" for purposes of removing transformers or for necessary work within the box. For high and low-tension connections in these boxes special switching gear, designed by the company's late chief engineer and Mr. C. E. Hodgkin, of the Brush Com-

reason for this being that there is no object in providing a two-phase supply in St. Luke's and Clerkenwell, where the direct-current supply prescribed by the Board of Trade is already given.

Some idea of the amount of street work may be gathered from the fact that the length of trenching in the northern districts to date is about 35 miles, the length of pipes laid is 100 miles, the high tension and power mains about 33 miles, the low tension cables about 40 miles, while the number of transformer boxes is 50. These districts, owing to their being chiefly of a business nature, have very much greater variation of load between summer and winter than the southern districts, which are chiefly residential.

WANDSWORTH STATION.

Owing to the peculiar configuration of the district of the Wandsworth District Board of Works, which extends from Richmond Park on the one side to the boundary of Camberwell at Streatham on the other (and also includes within it an outlying portion "or island" lying within the parish of Camberwell), and which contains some densely populated parts, alternating with sparsely built areas, difficulties arose as to the selection of a site out of many offering. It was, however, deemed of the utmost importance to select one in which the fuel could be cheaply transported and where a sufficiency of water for

condensing purposes and boiler supply could be obtained. Various sites could be had where one or the other desideratum was obtainable, but only one where there were both, and this was at the mouth of the River Wandle, where the present station is built, and on which the troubles arising from the rise and fall of the tide have no influence upon the supply of water to the station, since in the River Wandle an almost constant level can be maintained by means of the sluices and weirs, which have been made part of the general scheme of construction.

Buildings.—Owing to the better shape of the land and the absence of the onerous restrictions imposed upon the company with regard to the St. Luke's building lines, both boiler and engine room at this station are of the more convenient oblong shape with square ends, thus avoiding any waste space, as at the northern station. The main buildings are built up of best stock bricks and cement, and the engine room and switch room are internally lined with glazed bricks and floored over with "Adamant" tiles. At both stations, to prevent the hum of high periodicity alternating machinery being too easily conveyed outside, there is an absence of windows in the side walls of the building, the engine rooms being lighted from the roofs. The chimney is 200 feet in height, of hexagon shape and of an internal diameter of 12 feet at the top. The accompanying view shows the buildings already erected together with the coal conveying gear.

The boiler room and engine room occupy just one-half the available building space, and the foundations for the future extensions

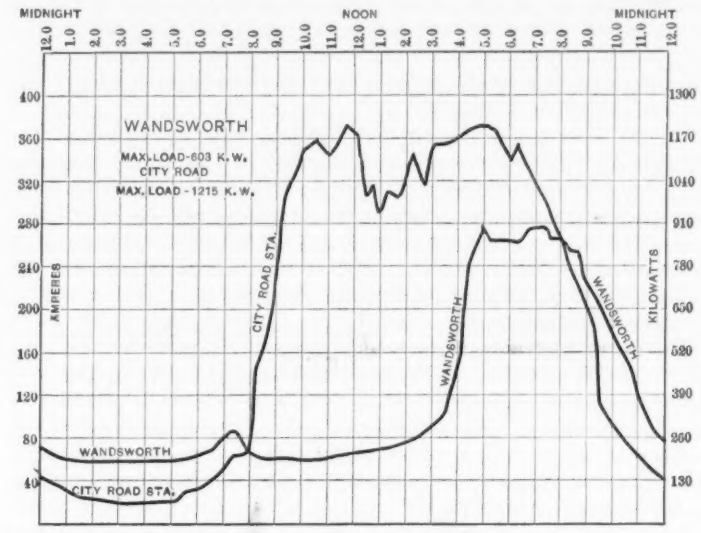

FIG. 12.—LOADS ON A FOGGY DAY (WANDSWORTH LOAD IN AMPERES, ST. LUKE'S LOAD IN KILOWATTS.)

have been partly laid in to the ground level. The offices and switch room occupy two-thirds of the available site for such accommodation adjoining the main building, but the company is provided with ample space for additional offices or repair shops on the other side of the River Wandle, between that river and Wandsworth Creek.

Boiler Room.—With a greater breadth of land than at St. Luke's, it was possible to erect on this site a boiler room 68 feet in width by 110 feet in length (occupying half the available site) in which the plans provided for a double row of boilers to be placed, their furnace ends projecting inwards and separated by a sufficient distance to allow of the withdrawal of the tubes from any boiler. On each side of the room there is space for eight boilers with economizers and by-pass flues. One side is now fully occupied and on the other side the foundations are already prepared for a similar equipment. Along the centre space between the boilers and under the floor level provision is made for ash conveying gear. The boilers, as at St. Luke's, are fitted with Babcock & Wilcox superheaters, Vicars automatic stokers and Green economizers. The economizer scrapers are driven by two small alternating-current motors. The feed tank is of the same construction as at St. Luke's, and the feed pumps, as at St. Luke's, are two Weir steam pumps of 4000 gallons capacity per hour each, against a pressure of 150 lbs. per square inch, but provided with injectors as auxiliaries instead of motor driven feed pumps.

Coal Conveying Gear.—The coal store above is of exactly the same general construction as at St. Luke's, but of course of larger storage capacity, as it corresponds in size to the boiler room below. The system of coal conveyance from barges to the coal store differs considerably from that adopted at the St. Luke's station, the motive power throughout being electricity supplied through two-phase 50 ℘

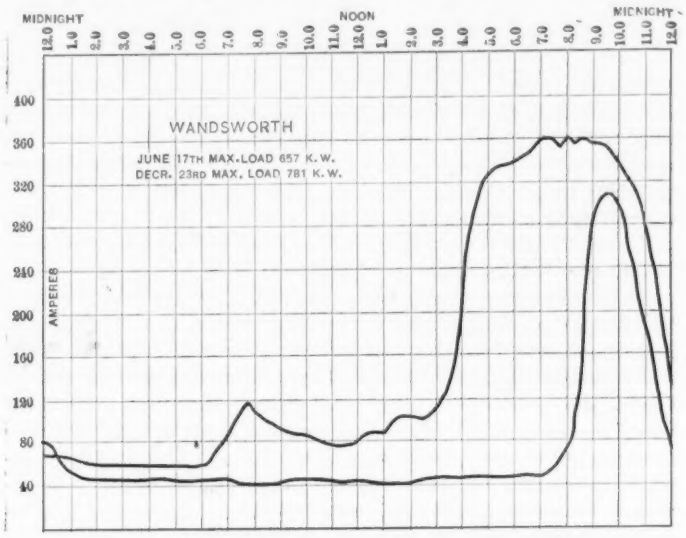

FIG. 13.— MAXIMUM LOADS, WANDSWORTH STATION.

motors at 200 volts. For each line of longitudinal conveyor a separate motor is provided, as well as a separate motor for the diagonal conveyor from the elevator by the weighing hoppor to the end of the coal store, and separate motors for the three elevators; and the lifting crane is also motor-driven. The motors are of the Westinghouse Company's manufacture. The apparatus is capable of dealing with forty tons of coal per hour.

Engine Room.—This building is 60 ft. in width by 110 ft. in length, and contains six Mordey single-phase alternating sets, 100 ℘, 2000-2200 volts and of 180-kw capacity each, driven by Raworth Universal engines, and installed on the side of the engine room next to the boiler room. On the other side provision has been made for five 400-kw two-phase 50 ℘ 2000 to 2200 volt alternators, now on order, to be driven by improved "Universal" engines, one on each side of a Mordey inductor alternator.

To provide for the practical parallel working of these machines of different periodicities and for economical working at times of light load by the use of one engine and alternator only, a motor-generator, as at St. Luke's, has been provided.

The exciting current is provided by three Brush direct-current compound-wound dynamos, driven by Brush marine-type cross-compound engines fitted with electric control governors. The steam piping is similar to that at St. Luke's, save that there is no cross feeding between the ends of the building. The overhead cranes are of 20 tons capacity. Circulating water from the Wandle comes into two separate tanks beyond the foundations for future extensions, and is circulated through the engine condensers, which are placed in this case under the floor level, by means of steam-driven centrifugal pumps, one of which is spare. The air pumps are also under the floor level, and are driven by a disc crank off the engine shaft. The condensed water is led off from these pumps by gravity to a tank connected with a Weir feed pump with an automatic valve admitting or shutting off steam according to the quantity of water in the tank, which lifts the water to a feed water tank similar to that in the St. Luke's station.

Switchboards.—The main switches for alternators, exciting circuit switches and rheostats are within the dynamo room, the current being carried by busbars through the dividing wall into a divided board placed immediately behind the alternator board in the circuit switch room. To the left of this main measuring board are the circuit panels for the mains for Putney, Wandsworth, Wandsworth Common, etc., while to the right there are twelve panels for transformer switches, which are connected up to mains leading into extra high-tension transformers placed in the basement of the switch room, which transformers raise the voltage from 2000-2200 to 6000-6600 volts, the E. H. P. side of which connects with the panels shown in the southern end of the switch room, whence the extra high tension mains lead to the main distributing transformer at Clapham, Streatham and Camberwell, where this extra high tension is again transformed down to 2000-2200 volts and delivered to transformer substations similar to those at St. Luke's, except that some of these transformer boxes in Camberwell are of the newer type of box.

Area of Supply.—As showing the extent of the area supplied from this station, it may be mentioned that while Roehampton by Richmond Park Gates on one side is distant along the route of mains

from the Wandsworth station 3⅜ miles, the furthest point in Streatham still within the district of the Wandsworth Board of Works is 5¼ miles, and Clapham by way of Battersea (a long detour having to be made to avoid passing through more than was necessary of the Battersea area), is distant from the station 5⅝ miles. Camberwell parish, however, which extends 5¼ miles from north to south and 2¼ miles from east to west, has its extra high tension distributing sta-

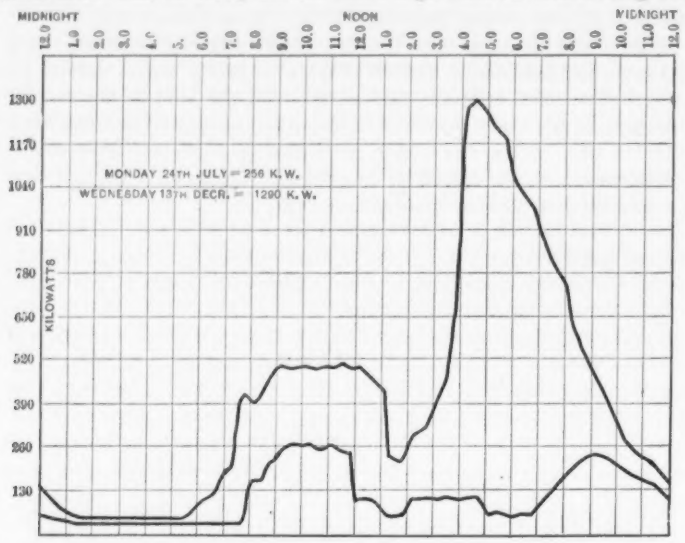

FIG. 14.—MAXIMUM LOADS, ST. LUKE'S STATION.

tion at a distance of no less than 10¼ miles from the Wandsworth station, and the extreme point of distribution in St. George the Martyr, Southwark, is 13¾ miles from Wandsworth, while the extreme point in St. Olave's Parish is 13½ miles, and is within the comparatively short distance of 2 miles of the City Road station, from which, however, several geographical and especially local conditions at present prevent its obtaining a supply.

Mains.—The mains throughout the whole of the Wandsworth and Camberwell Districts are drawn into cast-iron pipes, and the high-tension mains consist of rubber-insulated two-conductor cables lightly sheathed with steel and taped over, all made and supplied by the India Rubber & Gutta Percha Company, Silvertown, while the low-tension cables are Callender's jute and bitumen insulated lead covered two-conductor concentric cables. For St. Olave and for St. George the Martyr the high tension cables are of Messrs. W. T. Glover & Company's make, with paper and diatrine insulation and are, likewise, of the concentric two-conductor type.

The low tension throughout the whole of of these districts is supplied at 200 volts, instead of at 100 volts, as on the north side of the Thames, and the change from 100 ∅ to 50 ∅ is already commenced. It was decided to distribute current as single-phase in the Wandsworth district, where hardly any demand for power is likely to arise, balancing the lighting load as evenly as possible between the two-phase primary conductors; while in Northern Camberwell, St. George the Martyr and St. Olave, Southwark, where considerable power may be required, the mains have been laid for a bi-phase supply for both lighting and power.

In the Wandsworth, Camberwell and Southwark districts the length of trenching and reinstatement to date amount to about 75 miles, the length of pipes laid in to over 150 miles, high and extra high tension cable to nearly 50 miles and the low tension cable to over 52 miles. With the higher voltage on secondary mains, viz., 200 volts as against 100 volts on the north side, the number of transformer boxes for the much larger area is about the same as served from the City Road station, namely, 50, with three extra high tension converting and distributing stations above ground.

As these southern districts contain a large number of residences and a few in which late shopping takes place on Saturday nights, the Saturday night loads are generally the highest of the week, and so many private residences being connected to the mains, a fairly large load is obtainable on Sundays, thus strangely contrasting with St. Luke's station, where the Saturday and Sunday loads are hardly sufficient to require the use of two generating sets, and that only for a short period in the evening.

Representative load diagrams for one week each in midsummer and midwinter are given for each station. The peculiar hump in the middle of the diagrams for the City Road station is accounted for by the motor load which the station is now taking on. The sudden drop at about one o'clock corresponds to the British workman's dinner hour which, however, appears to be considerably longer than an hour, as the load only gradually rises between 2 and 3 p. m.

A Regenerative Controller.

BY JOHN C. HENRY.

NEARLY twenty years ago the celebrated German electrician Siemens pointed out some advantages in using shunt instead of series motors for electric traction, the principal ones being constant speed irrespective of the work (subject to manual regulation), and the co-operation between the cars on a system so that those descending grades assisted the others up, just as cable cars do.

About a dozen years ago Mr. Frank J. Sprague experimented considerably with such an arrangement and did much to educate the students in electric railways on this subject, but probably owing to the immediate and urgent demands for the more crude and less sensitive series motor, refinements and theoretical advantages were left by the wayside and the development of the regenerative system neglected.

Several years ago the writer took the subject up about where Mr. Sprague left it, and has since been engaged in putting the arrangement in commercial condition. Our improvements consist mainly in greatly increasing the range of regeneration and regulation, and also avoiding the very high voltage caused by self-induction when breaking the field circuits and of blending the circuits so that the motors are regulated by undulating the current rather than by violently interrupting it.

The distinct advantages of such a system are numerous. For instance, the movement of the car is regulated entirely by the controller—moving its lever forward speeds it up, while moving it backwards stops it. On stopping, or when descending grades, the voltage of the motor is raised above that on the line, in any of the following ways: By speeding up of the motors when the car is

Fig. 1

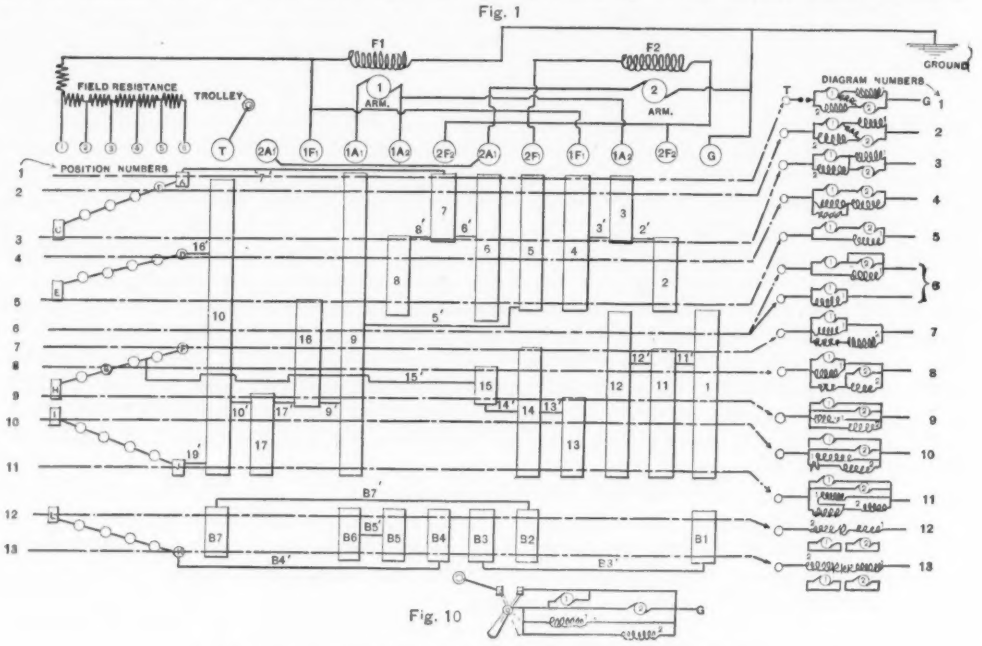

Fig. 10

DIAGRAM OF CONNECTIONS OF REGENERATIVE CONTROLLER.

descending a grade; increasing the strength of the fields by removing the regulating resistance; by changing them from series to parallel or by changing the armatures from parallel to series.

Under such conditions it is evident the motors driven by the car act as generators and supply the line, just the same as the generators do which are driven by the steam engines. It must be clear the amount of current regenerated is the same as is used in

ascending the grades or when starting the vehicle, less the numerous losses from friction, heat, etc., incident to electric traction.

As the braking is done by the controller and motors, the wear on car wheels, brake-shoes, etc., is entirely avoided, and it is obvious that the wheels cannot slide or flatten. The motors are electrically connected so that they are compelled to work together. Such a thing as one pair of wheels slipping and racing while the others are not driven, as is frequently noticed in the case of ordinary cars, is impossible with the construction shown. In railway work a great saving is effected by avoiding the use of resistance in the armature circuit in the running positions. The maximum speed of the car is pre-arranged, all danger from coasting is eliminated, and the car cannot run faster than the fixed speed down the heaviest grade, either with or without the trolley.

The method of control seems to be peculiarly suitable for automobiles. The ordinary methods of regulating such vehicles by grouping the cells is avoided, and the simplicity of control increased—the driver having but one lever to run or stop the vehicle. It is also well known that the efficiency of batteries is improved by frequent reversals.

The accompanying table gives the results of comparative tests made by Churchward, Chapman, Noble and Henry on Park avenue, New York city, October 25 and 26, 1899, between the ordinary series-parallel and the regenerative controlled vehicle.

A development of the controller with diagrams corresponding to the various changes is given in the diagram accompanying this article. An investigation will show that the e. m. f. of the motors is gradually decreased as the controller is moved forward, which makes them receptive to the current. It will also be observed that their e. m. f. is increased as the controller is moved backwards; thus regeneration is maintained as the speed of the vehicle decreases. In the starting position, diagram 2 shows the motors coupled as series machines connected in parallel in juxtaposition with a tie of high resistance between them. The resistance of the fields is high (they being wound with fine wire), thus preventing the armatures from taking but a small amount of current. At the same time, great starting torque and slow speed are ensured by the intense fields. When the circuit is broken the flash is very small, as the self-induced current from the fields is short-circuited through the armatures. In position 3, shown in diagram 3, a permanent connection is substituted for the resistance cross-connecting the motors, thus changing them from series to shunt-wound machines. It will be noticed in the intermediate steps that the motors are of a nameless variety, i. e., a cross between series and shunt; they are still, however, cross-connected, so that the tendency for one armature to run faster than the other is checked. The changes from series to parallel is made by gradually short-circuiting the fields of motor No. 2 so that its armature may be short-circuited, it having previously been deprived of its e. m. f. To connect the motors in parallel, field No. 2 is partially excited from the line, having resistance in series with it. The armature is thus connected in shunt with the fields, it being driven by the car as a shunt dynamo, counteracts the line voltage, which is low after passing through the high field resistance; in consequence, the second armature may be connected to the circuit without mechanical shock. After the motors are in parallel they may be speeded up by weakening their fields, as shown in diagrams 10 and 11.

HENRY MOTORS.

Notch.	Grade.	Amps.	Volts.	Time.	Watt Seconds.
First	¾ per cent.	10	95	:40	38,000
Second	¾ "	16	93	:31	46,128
Third	¾ "	21	91	:26	49,686
Fourth	¾ "	24	90	:21	45,360
First	2½ "	20	92	:51	
Second	2½ "	31	88	:40	109,120
Third	2½ "	37	86	:31	98,642
Fourth	2½ "	43	85	:26	95,030
First	5 "	26	88	:50	
Second	5 "	39	85	:45	149,175
Third	5 "	48	82	:31	122,016
Fourth	5 "	55	80	:32	140,800

STANDARD MOTORS.

Notch.	Grade.	Amps.	Volts.	Time.	Watt Seconds.
First	¾ per cent.	13½	50	1:55	77,625
Second	¾ "	14	97	:45	61,110
Third	¾ "	28	95	:25	66,500
Fourth	¾ "	40	94	:18	67,680
First.....	2½ "		Stalled.		
Second	2½ "	24	96	1:05	149,760
Third	2½ "	56	90	:40	201,600
Fourth	2½ "	60	90	:21	113,400
First.....	5 "		Stalled.		
Second	5 "	31	93	1:18	224,874
Third	5 "	63	88	:37	205,128
Fourth	5 "	76	85	:25	161,500

SUMMARY.

Watt Seconds. E. V. Standard.	Watt Seconds. Henry.	Henry, per cent. of gain.	Speed Notch.	Grade.
77,625	38,000	104.29 per cent.	1st	¾ per cent.
61,110	46,128	32.4 "	2d	¾ "
66,500	49,686	33.8 "	3rd	¾ "
67,680	45,360	40.9 "	4th	¾ "
Stalled.			1st	2½ "
149,760	109,120	37.3 "	2nd	2½ "
201,600	98,642	104.3 "	3rd	2½ "
113,400	95,030	19.3 "	4th	2½ "
Stalled.			1st	5 "
224,874	149,175	50.7 "	2nd	5 "
205,128	122,016	68.1 "	3rd	5 "
161,500	140,800	14.9 "	4th	5 "

Average gain in efficiency for Henry motors, 32 per cent.

Average. 48.68 "

Wisconsin Independent Telephone Companies Organize.

In response to the call of A. L. Hutchinson, of the Wolf River Telephone Company, nineteen of the independent telephone companies, representing 1900 miles of toll lines and 5000 subscribers of Wisconsin, met in Weyauwega, Wis., on March 20, to organize in a determined effort to protect their interests against the Bell Telephone Company. Recognizing the fact that the Bell Company is absorbing an independent company here and there to the detriment of the interests of the smaller companies, a united effort was made to cement the largest of the 75 independent companies in Wisconsin and extend their lines so that a service could be established which could compete advantageously with the Bell Company.

At this meeting it was resolved that the aim of the association should be "The bringing about of a complete system of intermunicipal communication and long distance trunk lines within the state of Wisconsin and to co-operate with independent companies in other states." The following officers were elected: President, A. L. Hutchinson, Weyauwega; vice-president, C. H. Schweizer, La Crosse; secretary-treasurer, H. C. Winter, Madison.

It was decided to divide the state into eight districts, and to have the executive committee made up of representatives from each district. The following is the board: First district, Richard Valentine, Janesville; second district, W. R. Hoppe, Knowles; third district, Clark Pease, Richland Center; fourth district, W. Bell, Baraboo; fifth district, Judge Gaynor, Grand Rapids; sixth district, Dr. L. H. Jones, Wayauwega; seventh district, Emil Mauer, Arcadia; eighth district, an officer of the Sunset Telegraph Company of West Superior. The next meeting of the association will be held at Madison the second Wednesday in June.

The companies represented were: Janesville—Richard Valentine, Rock County Telephone Company; Baraboo—William Y. Bell, Baraboo Telephone Company; Fort Atkinson—A. M. Webb, Jefferson County Telephone Company; La Crosse—Charles H. Schweizer, La Crosse Telephone Company and La Crosse & Southeastern Telephone Company; Sparta—Howard Teasdale, Monroe County Telephone Company and Tomahawk Telephone Company; Portage—W. H. Little, Portage Telephone Company; Grand Rapids—John A. Gaynor, Wood County Telephone Company; Marshfield—E. M. Denning, Marshfield Telephone Company; Weyauwega—Joseph Vogt, Wolf River Telephone Company; Madison—H. C. Winter, Dunn County Telephone Company; Mentello—Charles A. Colonius, Central Wisconsin Telephone Company, and several others.

Suspended Electric Railway.

An interesting electric railway system will soon be put in service in Germany, the line running from Barmen through Elberfeld to Vohwinkel, a distance of about eight miles. The system consists essentially in the employment of a single rail fixed to the under surface of a viaduct, which latter is supported by a light lattice work construction. No less than six miles of the line is supported over the Wupper River, the construction here used being shown in Figs. 1 and 2. Over other portions of the route an arched support is employed, as shown in Fig. 3. The minimum radius of curves is 300 feet and the steepest grade 4.5 per cent.

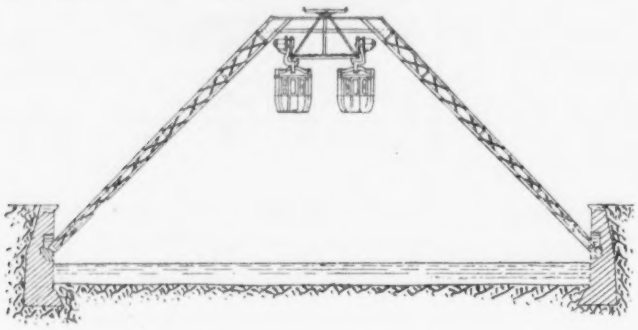

FIG. 1.—METHOD OF CONSTRUCTION OVER RIVER.

The cars are suspended flexibly to permit of going around abrupt curves. At a speed of 15 miles per hour the car body is inclined at an angle of 25 degrees when passing around curves, without, however, any inconvenience to passengers, it is stated. Each suspension truck is supported by two driving wheels, which receive power from an electric motor through gearing by means of an intermediate pinion meshing with a pinion mounted on the axis of the motor, and with a spur gear on the wheel.

The motors are rated at 36-hp at 500 volts, and are controlled on the usual parallel series system from the front platform of the first carriage of a train. The current is taken from a light rail by means of a sliding shoe held in contact by a spring. In the case of a train of two or more cars, the first car alone is fed directly by the current, a flexible cable of several wires supplying the necessary current to the other cars for motors, incandescent lamps or bells. Every car will have a motor equipment. Westinghouse air brakes are used, the reservoirs being refilled at the terminal points of the line. It is proposed to run the cars at a speed of 30 miles per hour, which will give an average speed of from 18 to 21 miles an hour. Trains of two cars will run under a headway of two minutes, and will be controlled by an automatic block signal system.

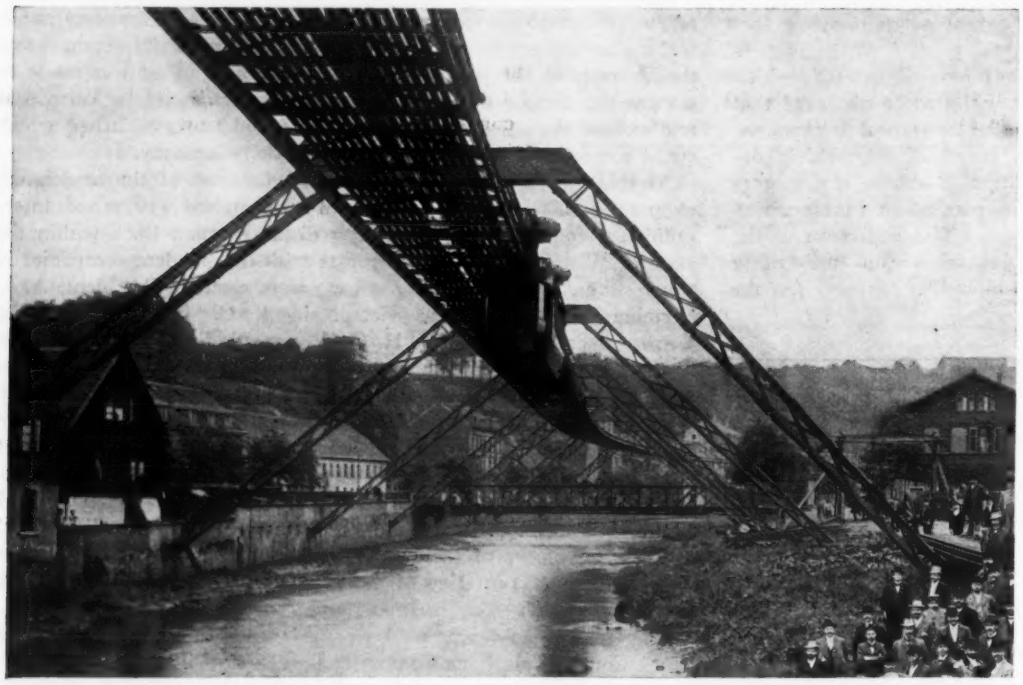

FIG. 2.—GENERAL VIEW OF SUSPENDED ELECTRIC RAILWAY.

The cost of the line proper will not, it is stated, exceed $200,000 per mile. The cost of the equipment of the system will be $540,000, on the basis of a train every three minutes, carrying 100 persons at a speed of from 24 to 30 miles an hour.

Electrical Engineering Laboratory of University of Illinois.

The College of Engineering of the University of Illinois occupies a compact group of buildings, the largest of which is Engineering Hall, which was erected in 1894 at a cost of $160,000. On the ground floor are the testing rooms, the workshop of the department of physics, the draughting rooms of the department of electrical engineering and the laboratories of the department of civil engineering. The general laboratory of physics is on the third floor. Near by is the mechanical and electrical engineering laboratory, which was erected in 1897 at a cost of $30,000.

The electrical engineering laboratory contains in the dynamo department various types and sizes of direct and alternating current dynamos, motors and rotary converters, and all of the necessary apparatus for making individual and complete tests of them. This equipment includes a 300-light alternator, a 40-hp two-phase induction motor, a single-phase and a three-phase induction motor of 2-hp each, two types of Thomson-Houston arc light machines, three types of 500-volt motors, a 110-volt motor, a 220-volt dynamo and a number of 110-volt dynamos, two 7½-kw rotary converters for 160 volts direct current and 110 volts alternating current of one, two or three-phase; two small single-phase alternators and a number of battery and fan motors.

Special transformers are provided for all classes of work in polyphase testing and of capacities adapted to the laboratory requirements.

A marble switchboard, consisting of eight panels each, for direct and alternating currents, has been designed and installed with every appliance for the expeditious handling of electric currents. Dynamo, motor, transformer, converter and distributing panels provide every facility for all classes of distribution for the laboratories and the several testing rooms, and for electrical supply from the storage battery installation, laboratory machines for the university electric light and power plant.

A large collection of the best measuring instruments includes ammeters, voltmeters and wattmeters of standard makes. Siemens electrodynamometers, Kelvin balances, electrostatic voltmeters, recording meters, hysteresis meters, electrometers, condensers, inductive and non-inductive resistances, lamps, German-silver, carbon and water rheostats, a Brackett cradle dynamometer, tachometers, revolving contact makers, and other devices and appliances which are essential to the thorough experimental study of direct and alternating currents.

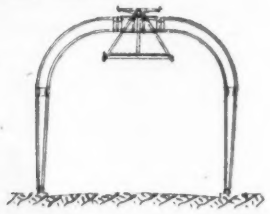

FIG. 3.—ARCHED SUPPORT.

A standardizing laboratory is equipped for accurately measuring current and electro-motive force, thus admitting at all times of ready calibration of the instruments used in the laboratory. An experimental telephone and signaling line has been erected, and several sets of receivers and transmitters have been provided for testing purposes. A high-potential testing transformer, with a specially designed electrically heated oven, and other accessories, facilitate disruptive tests on insulators and insulating materials.

The photometry rooms are supplied with two electric light photometers, one of which is the latest type of Kreuss-Bunsen apparatus fitted with a standard Hefner lamp and various accessories. There are numerous types of incandescent lamps and of continuous and alternating arc lamps; various conveniences for making candle-power, life and efficiency tests are provided. The battery room contains a collection of primary cells, and over 90 cells of secondary battery, including several makes, fitted with switchboard and testing conveniences. The workship is supplied with an engine lathe, a speed a lathe, a universal milling machine, a grinder, etc., and a line of fine tools. An electric motor furnishes power for this shop. The services of an experienced mechanician enable the department to manufacture special apparatus as required.

The university electric lighting and power plant is available for tests by the department. It consists of two two-phase alternating current dynamos, one of 75-kw and one of 45-kw capacity, with four induction motors, having a combined output of 100-hp; a 30-kw 500-volt constant potential generator with six motors, and a series arc light machine for lighting the grounds and armory. Transformer capacity of the alternating plant is for 700 16-cp incandescent lamps. The prime motors for the plant are 100-hp and two 50-hp steam engines.

Engineering Laboratories at Columbia University.

Washington's Birthday was celebrated at Columbia University by opening for inspection to a large number of invited guests many of its buildings and all the laboratories. Several thousand guests availed themselves of this opportunity of paying a first visit to the University. The apparatus and machinery were explained by attendants to the throngs that passed through the laboratories the entire afternoon.

In the locomotive section of the mechanical laboratories, the big Baldwin compound "Columbia" was of particular interest. The engine was run for the first time since it had been mounted at the University, compressed air being used for motive power, which turned the big 84-in. drivers at a 20-mile speed. Preparations are being made for a regular course in railroad engineering, when the locomotive will be run either by steam from its own boiler, or by steam from the University power house.

In another department is a Westinghouse airbrake equipment, with pump, valves, car reservoirs, and train pipe complete, the gift of the Westinghouse Airbrake Company. A number of other machines were on exhibition, among which was a standard trolley car, the gift of the J. G. Brill Company, equipped with electric motors. Also a large experimental triple expansion Corliss engine, the gift of the sons of Edward P. Allis. It can be run either as an ordinary power plant engine or driven as a three-stage air compressor with inter-coolers, giving compressed air at 250 lbs. In the Worthington section of the mechanical laboratories is the hydraulic machinery, the gift of Mr. C. C. Worthington as a memorial to his father. Water can be put under a pressure of 5,000 lbs. per square inch in the high pressure pump of this triple expansion, duplex, pumping engine.

A recent gift has made possible the acquisition of further electrical machinery for the laboratory of the department of electrical engineering. New machines have been ordered to duplicate the present plant, and will soon be erected in the direct and alternating current departments. These will include a Westinghouse double-current generator, supplying two-phase alternating current from the collector rings, and direct current from the commutator; also a Westinghouse direct-current motor to operate the generator. These additions will provide greatly needed facilities to the students in the dynamo room, where there have been a large number for several years. The field of electrical engineering is a very promising one for college students, as there is a steady demand for the services of engineers who have been thoroughly grounded in the theoretical branches, and who have supplemented this with practical work in the shops. Some of the larger electrical companies have an apprenticeship system for those who have taken an electrical course at one of the Universities.

Rubber Culture in Hawaii.

It is reported that the Department of Agriculture will send 100,000 rubber trees to Hawaii where it is thought the soil is adapted for raising rubber crops.

Breaking Ground for the New York Rapid Transit Tunnel.

Ground was broken on Saturday afternoon last with appropriate ceremonies in City Hall Park for the New York rapid transit tunnel. The park was packed with thousands of people who came to witness this important event in the history of the city. Mayor Van Wyck made an address and was followed by Mr. Alexander E. Orr, who spoke in behalf of the Rapid Transit Commission.

At the close of Mr. Orr's speech August Belmont handed a silver spade to the mayor. The mayor had dumped the first shovelful of earth upon the pavement and was about to step out of the excavation, when he turned suddenly back again. Taking off his silk hat, he placed it upon the ground, and digging up another spadeful of earth he emptied it deliberately into his hat. That shovelful, he explained, he meant to distribute as souvenirs.

The silver spade was then in turn handed to Mr. Orr, the other Rapid Transit Commissioners, Mr. McDonald, the contractor, and Secretary Burrows, each of whom took a part in the excavation. Then a bronze tablet was fitted into the space, and at the end of the process Comptroller Coler made the closing address.

There were about 25,000 people present at the ceremonies. Contractor McDonald is reported to have said that trains will be running through to Harlem by March 24, 1903, three years after breaking ground. On Monday last sub-Contractor Pilkington began the work of lowering the Bleecker Street sewer in order to provide enough room for the tunnel in crossing that street. Contractor McDonald says he will have 20,000 men employed on the work of tunnel building in a short time.

The Bell Telephone Union.

A despatch from Boston states that on Tuesday of this week the union of the American Bell Telephone Company and the American Telephone & Telegraph Company was perfected by a vote of the stockholders of the former corporation. The financial showing for the year 1899 showed that the earnirgs were $5,760,106.45 in comparison with $5,448,701.49 for the previous year. At the same time, the expenses have decreased a matter of $321,000 and the regular dividends for the year foot up $3,106,356, with an extra dividend of $776,589.

In the circular letter issued by President J. E. Hudson to the stockholders of the American Bell Telephone Company regarding the business to come before the annual meeting on March 27, that gentleman said, with reference to the proposed ratification of the assignment to the American Telephone & Telegraph Company of the property of the company, other than Long Distance Company stock:

The American Telephone & Telegraph Company (the Long Distance Company, so-called) was organized under the circumstances set forth in the fifth and six annual reports of your directors for building lines of connection between large cities, substantially connecting together the territories of our several licensees. The demand for such service was first tested betwen the cities of New York and Philadelphia, and little later between the cities of New York and Boston. The advantages offered by these long lines were soon recognized by the public and the business done over them increased rapidly. Encouraged by the growth of its business the Long Distance Company extended its lines until they now connect almost all of the large cities and towns in the United States lying east of Omaha and Kansas City. The capital of the company has been increased correspondingly.

In the development of the business it was necessary that the Long Distance Company become the owner of shares of the capital stock of many of our licensees. These holdings constantly increased until it was thought wise by your directors that all the stocks and bonds of our licensees held by this company and the Long Distance Company should be under one control. The existing statutes made it necessary that that control be vested in the Long Distance Company. In consequence that company has (by purchase from this company) become the owner of all the stocks and bonds of our licensees formerly held by the two companies.

This, under the statutes of Massachusetts and New York, was the logical development of the business. As a result, this company, in addition to its stock in the Long Distance Company, remained the

owner only of certain patents, its telephones, the contracts with our licensees and some miscellaneous assets.

It has seemed wise to your directors to transfer to the Long Distance Company, subject to your ratification, the above remaining assets of this company, except its stock in the Long Distance Company.

In case of such ratification, the company will have the stock of the Long Distance Company as its sole remaining asset. After providing adequate protection for its indebtedness, the company will be able to make a division of two (2) shares of the stock of the Long Distance Company for each one (1) share of the stock of this company, and your directors have consequently unanimously recommended to the stockholders that they be authorized to make such distribution, each shareholder, on receiving two (2) shares for one (1) of his present holdings, to transfer his stock in this company to or in trust for said Long Distance Company. It will be remembered that this company now owns substantially all the stock of the Long Distance Company.

There are several advantages to be derived from this plan, the chief among which is the power to consolidate with or hold stock in connecting or subordinate companies, the statutes of Massachusetts prohibiting this corporation, with certain exceptions, from becoming a stockholder in any other corporation to an amount exceeding 30 per cent. of the capital stock of such other corporation, and thereby preventing this corporation from meeting the business requirements of the United States as they exist to-day.

CURRENT NEWS AND NOTES.

TELEPHONE STATISTICS.—Recent statistics show that nearly 1,200,000 miles of copper wire are used in the telephone service in this country, and that 3,823,070 connections are made in all the exchanges in the country every day.

THE INDEPENDENT TELEPHONE MOVEMENT.—It was stated in Philadelphia last week that the Telephone, Telegraph & Cable Company had purchased the Market Street conduits, wires and poles of the Standard Telephone Company, of that city.

INDEPENDENT LONG DISTANCE LINES IN PENNSYLVANIA.—It is reported that representatives of independent telephone companies in Pennsylvania will meet in Harrisburg on April 10, when a plan for establishing a long distance system will be considered.

CHICAGO ELECTRICAL ASSOCIATION.—The secretary of the Chicago Electrical Association informs us that the title of the paper to be read by Prof. I. J. Macomber before that society on April 6, has been changed to "Transformer Design." The subject as originally announced was "Laboratory Methods."

THE RAPID TRANSIT COMMISSION.—The New York Senate Committee on Cities has favorably reported the bill which provides for an extension of the powers and duties of the Rapid Transit Commissioners to all the Greater New York boroughs, and puts all construction of tunnels, bridges and other means of rapid transit communication, surface or underground, within their control.

SOCIETE INTERNATIONALE DES ELECTRICIENS.—At the March meeting of the Société Internationale des Electriciens, M. Zetter read a paper on fittings for 220 and 440-volt circuits. A second paper was by M. X. Gosselin, who gave a summary description of the new Bois de Boulogne electric railway, part of which is on the overhead trolley system and part on the Vedovelli surface contact system.

CURRENT CONVERTERS.—A patent was granted March 20 to Alfred Wydts and Gustave Weissmann, of Paris, France, which describes an apparatus for the conversion of direct currents of one voltage into direct currents of another voltage. The apparatus is a combination of a rotary converter and rectifier. By means of the former the direct current is transformed into alternating current; the alternating current is then stepped up or down in voltage. and finally rectified so as to produce a direct current.

RECORDING WATTMETER.—It has been noticed that wattmeters provided with a starting coil and subject to vibration, are maintained in slow motion on open circuit, a result due to the weak torque afforded by the armature and starting coil. A patent granted March 20 to E. W. Rice, Jr., provides means for periodically cutting down the torque of the armature during each revolution, whereby in effect a dead point or points is produced at which the creeping of the meter will be arrested. Such points of weak torque are obtained by introducing at suitable points on the armature winding a demagnetizing coil to weaken the magnetizing value of the armature current at determinate points of the air core.

INSURANCE AND ELECTRICITY.—The Equitable Life Assurance Society will have an exhibit at the Paris Exhibition, the most striking feature of which will be an electrical display representing the marvelous growth of American life insurance. For this purpose fac-similes of the Statue of Liberty in New York Harbor, the Eiffel Tower, Arc de Triomphe and other objects of interest, both in America and France, will be represented in vari-colored electric lights. The Equitable's exhibit is now on its way across the ocean, and will be on view in two places at the Exposition, as in addition to a space in the United States section of social economy, it will have a larger space in the American section of the Publishers' Building, where its main exhibit will be placed.

THE AMERICAN STREET RAILWAY ASSOCIATION.—In our issue of March 3 was given a partial list of the papers to be read at the next meeting of the American Street Railway Association, which will be held in Kansas City, Mo., on Oct. 16, 17, 18 and 19, this year. This meeting will be no exception as regards extent of exhibits of apparatus and supplies. The exhibition will be held in the convention hall, where there is an abundance of floor space and all the light, heat and power that will be needed. The executive committee has fixed the price for space at ten cents per square foot, and ruled that no space of less than 100 square feet will be assigned. Applications for space should be addressed to W. A. Satterlee, Fifteenth and Grand Avenue, Kansas City. The railroads will sell tickets on the certificate plan.

FREE EVENING SCHOOLS FOR MECHANICS.—The General Society of Mechanics and Tradesmen has moved into the spacious building formerly occupied by the Berkeley School, in West Forty-fourth Street, New York, and has fitted up the greater portion of the building as school rooms where instruction is given three nights each week in all branches of mechanical, architectural, free-hand and ornamental drawing, and mathematics. The equipment of the school is modern and the instruction practical and thorough. The society's extensive library is accessible to the students as well as a complete set of models which have recently been purchased. The course begins early in October, but to insure registration, applications may be made now by calling at the school building, 20 West Forty-fourth Street, any Monday, Wednesday or Friday evening between 7:30 and 9:30.

DYNAMO-STATIC MACHINE.—A patent granted March 20 to Elihu Thomson relates to the apparatus for obtaining high frequencies and pressures, which formed the subject of a lecture delivered before the New York Electrical Society, an abstract of which appeared in our issue of Oct. 14, 1899. A condenser is alternately charged in parallel by current from a high voltage transformer and discharged in series, the charging contact being made only at or near the peak of the alternating current wave. The contact device is driven by the motor-dynamo supplying current to the transformer, and cuts out waves of opposite polarity to that desired. By an apparatus of this kind dynamic currents can be transmuted into static charges of extraordinary potential capable of reproducing in all respects the phenomena of static electricity as generated by frictional or induction machines.

THE TELEPHONE, TELEGRAPH & CABLE COMPANY'S PLANS.—It is reported that the Telephone, Telegraph & Cable Company of America is making arrangements with various telephone companies throughout the west for the purpose of establishing a through independent system to the Pacific coast. Among the west-

ern lines with which negotiations are said to be pending are the San Francisco lines and those in Oregon and Washington; the Rocky Mountain system, with branches in various directions from Denver, and various systems between Denver and the coast. Steps are also being taken to obtain control of the Cincinnati & Suburban Telephone Company, which is one of the most important of the intermediate systems. The policy of the new movement will be to have a strong company in each state. These companies in turn will furnish the funds with which to buy companies competing with the Bell Company.

INDEPENDENT TELEPHONE MOVEMENT IN VIRGINIA.—At the present session of the legislature of Virginia application was made for a charter granting special privileges for building long distance telephone lines in Virginia, but was not enacted into law. In the opinion of many, to accord the privileges asked would be disastrous to the independent telephone interests of the state, both city and county, and a meeting will be held at Murphy's Hotel, Richmond, Va., April 4, for the purpose of organizing a state long distance telephone company to complete a system of lines connecting all points in Virginia. Those interested in the independent telephone movement have been invited to attend this meeting, and it is the desire of those at the head of the movement that all local exchanges shall become stockholders and that the stock shall be owned in every city and county in the state. We glean this information from a circular sent out by Mr. James R. Kemper, of Fisherville, Va., in which the call for the meeting is made.

A TESLA PATENT.—A patent issued March 20 to Nikola Tesla relates to the production at one point of an electrical pressure of such character and magnitude as to cause thereby a current to traverse elevated strata of the air between the point of generation and a distant point at which the energy is to be received and utilized. As illustrated, the apparatus consists of a generator supplying current to the primary of a transformer; the secondary consists of many turns and is connected at one side to the earth and at the other side to a terminal of large surface, maintained by such means as a balloon at a high elevation. The receiver duplicates this apparatus, except that instead of a generator being in one circuit of the transformer, receiving devices such as lamps and motors take its place. The transformer consists of a coil of very large diameter wound in spiral form, either with or without a magnetic core. The inventor claims that this furnishes a practical method or system of transmission of energy through natural media without the use of wires.

ELECTRICAL PHOTOGRAPHY.—Prof. F. E. Nipher delivered an illustrated lecture before the Academy of Science of St. Louis, on the evening of March 19, demonstrating the manner in which electrical discharges are photographed, and how the negative may be developed in the dark room, not with the aid of the usual dark ruby lamp, but with an incandescent electric lamp. He illustrated the result of his work with stereopticon slides. The negatives were made by the spark of a Holtz apparatus. To prepare the plates it was necessary to expose them to the light from one to ten days. To take a picture on one of these negatives it was necessary to darken the room, as the light made it impossible to produce the electrical object. The negatives were developed in the dark room by a glowing white incandescent light. Fogging is eliminated by proximity to the light instead of the usual treatment. The regular developing solution is used. Aside from the usual electrical discharges as exhibited by photographs, the most startling picture was one of ball lightning.

MULTIPLE GENERATING SYSTEM FOR ELECTRIC RAILWAY OPERATION.—When trains or cars are infrequently run, especially on long-distance high-speed railways, there are periods when considerable sections of road require no supply of current. To obviate the loss incident to such service when all of the energy is generated at one or few points of the line, Mr. George Westinghouse in a patent issued March 20 describes the following system: A series of electric generators located at intervals along the line of a railway are driven by gas engines supplied from a general gas distributing system. The line is divided into sections corresponding to the various generating stations, and current is only generated for a section when it is required to operate a car running on that section. Means are provided for signaling the approach of a car to a section, and to connect for current supply to either adjacent section should the demand for current exceed the normal output of the generator. The gas engines are promptly started for generating service by means of compressed air, each station being supplied with compressors. The same system may be applied to electric light and power systems extending over wide areas, or to take care of "peak" loads.

A STEAM-ELECTRIC LIGHTSHIP.—One of the most dangerous localities along the North American Atlantic coast is Cape Hatteras, and the natural obstacles there have so far baffled every attempt to mark the dangerous shoals for the warning of mariners. The last lightship placed there was torn away from her moorings. A lightship of special design to meet the exceedingly severe local conditions is now being built at the yards of the Fore River Engine Company in Massachusetts. The vessel will be steam propelled and electrically lighted, and will, it is thought, be the most efficient lightship ever built. The dynamos and their engines will be located on the main deck within the engine and boiler casing. The wires for the masthead lights will run through the interior of the two hollow steel masts. Each mast will support a cluster of three 100-volt lamps of 100-cp each, and these lamps will be controlled by an automatic flashing device. This will be driven by means of a belt from the dynamo shaft and a worm and worm wheels which will give the proper rotary speed to a circuit breaker. The ship will be lighted throughout by eighty 16-cp 100-volt lamps. The dynamos will be driven by two noncondensing, double cylinder engines, running under steam at 80 pounds pressure.

REGULATION OF DOUBLE CURRENT GENERATORS.—The regulation of double current generators is ordinarily attended with considerable difficulties. Unlike when working as rotary converters, the armature reactions do not oppose each other, but on the contrary act in conjunction to vary the field strength of the machine. The armature reaction, therefore, depends upon the total load, and unlike the case of the rotary converter the brushes require to be shifted more or less as the load changes. Since the effects of armature reaction depend upon both the alternating and direct current loads, it follows that a device responsive to one only of these loads is ineffective in regulation. In a patent granted March 20 to Charles P. Steinmetz a method is described for securing the desired regulation automatically and by means responsive to variations of load in both circuits of the machine. To compensate for the direct current load a series field winding of suitable proportions is employed in addition to the usual shunt winding. To compensate for the armature action due to the alternating current, which depends upon both the shifting of phase and the magnitude of the current, suitable reactive coils are used in connection with a rotary converter or synchronous motor on the transmission line.

A TRIBUTE TO MR. VREELAND.—In the course of an interview relating to the recent absorption of the Third Avenue Railway in New York by the Metropolitan interests, ex-Secretary of the Navy Whitney referred to Mr. Herbert H. Vreeland in the following terms: "Mr. Vreeland's judgment was accepted by us. We left everything to him. We have every confidence in him, and after we told him to go ahead and he reported favorably we did not hesitate to act on his judgment. He is a wonderful man, and I wish to give him full credit for what he has done. His judgment has never failed us, and in the present instance he has again given evidence that it is safe to follow it in matters pertaining to street railroad affairs. He advised us to get control of the Second Avenue road when the stock was away down, and we did so, although many persons could not see where we were to get our returns. Mr. Vreeland even went so far as to say that we could afford to lease the lines and guarantee to pay 8 per cent. on the stock, which was done. Since we took possession of the Second Avenue road every one has profited by it. All the stockholders are receiving 8 per cent. dividends, but we have benefited aside from this, for stock which we bought away down is now selling at 200 and promises to increase in value."

POLE-CLIMBING CONTEST—One of the features of the Military Tournament being held at Madison Square Garden during the present week is a pole-climbing contest between teams representing the First and Second Signal Corps, N. G. N. Y. There are six poles, as nearly uniform as possible, each pole having a spike driven on one side at a point thirty feet from the base, the spike protruding about

twelve inches; there are also two sets of cards numbered from one to twenty, each supplied with a loop of string of a sufficient size to be slipped over a man's head. The poles are arranged in two rows, three in each row, at opposite sides of the arena, and the numbered cards placed on a table in the centre of the arena in two piles with the lowest number at the top in each. The contest consists in placing the numbered cards on the spikes on the poles, under the following conditions: Each corps is represented by a team of six enlisted men who have been members of their respective organizations at least two months, and whose daily employment does not include pole-climbing, or have been in the past employed as professional linemen. The contest consists of three heats of three minutes each, and the team winning two heats shall win the contest and be awarded the trophy. At the signal to start, the contestants take the numbered cards from the table, one at a time, and place them on the spikes on the poles of their respective teams, climbing the poles for the purpose and descending to the ground each time a card is so placed; no contestant has at any time more than one card in his possession, and not more than one contestant is on a pole at a time. At the signal to stop, the team having the greater number of cards hanging from its spikes on the poles is named the winner of the heat.

ELECTRIC LIGHTING IN THE DISTRICT OF COLUMBIA.—A bill was recently introduced in Congress for the purpose of bringing about a reduction in the price of electric current in the District of Columbia. In order to obtain information on the subject, the House District Committee requested the District Commissioners to supply it with data relative to the cost of electric lighting in other cities. Replying to this request the commissioners have transmitted to the committee a statement showing the amounts paid for electric arc lighting in forty-six states and territories, some of which are for all-year service and some for a part of the year, indicating the average amount paid for each light to be $97.10. The data regarding the cost of arc lamps in forty-six states and territories was obtained from the General Electric Company. The following are the average contract prices per lamp per year in each of the sections referred to: Alabama, $85; Arizona, $121.50; Arkansas, $128.43; California, $98.20; Colorado, $129.50; Connecticut, $84.40; Delaware, $100; Georgia, $84.15; Idaho, $112; Illinois, $70.75; Indiana, $76.50; Iowa, $74.30; Kansas, $71.39; Kentucky, $78.50; Louisiana, $113.75; Maine, $68.10; Maryland, $84.55; Massachusetts, $94; Michigan, $74.30; Minnesota, $89.56; Mississippi, $101.33; Missouri, $96.50; Montana, $137.90; Nebraska, $104.85; Nevada, $196; New Hampshire, $81.50; New Jersey, $103.50; New Mexico, $127.50; New York, $90.80; North Carolina, $90.33; North Dakota, $98.40; Ohio, $77.50; Oregon, $107.57; Rhode Island, $114.06; South Carolina, $77.40; Pennsylvania, $77.90; South Dakota, $108.33; Tennessee, $86.20; Texas, $108.10; Utah, $16.25; Vermont, $67.60; Virginia, $75.80; Washington (state), $105.61; West Virginia, $80.50; Wisconsin, $77.70; Wyoming, $169.50; Hawaiian Islands, $96. Total average, $97.10.

APPLICATIONS OF ELECTROLYSIS.—In a recent paper read before the Chicago Electrical Association, Mr. C. F. Burgess illustrated in an interesting manner the scope of electrolytic action by reference to an old file. Imagine, he said, that we have an old rusty file, which has been pretty well worn, with the tang broken off, covered with oil and grease, and upon which paint or varnish has been spilled. We may first suppose it to be suspended as the cathode in a solution of common salt, and current under a pressure of about six volts caused to pass. A rapid formation and evolution of gas bubbles will be produced upon the surface of the iron, and these will exert the physical effect of working under the paint and varnish and thus quickly freeing the surface of these materials. The sodium, which is liberated by the current, unites with the water to form a caustic alkali solution at the iron surface, and this has the action of saponifying the oil or grease, just as would be done were the greasy article boiled in a lye solution. Again, the reducing action of the sodium and hydrogen will cause the brown rust to entirely disappear. We may now reverse the direction of the current, and the file which has been cleaned of paint, oil and rust will become evenly and uniformly corroded or dissolved, with the result that the teeth become more pointed and producing a sharpened file. To shape a new tang to fit into the wooden handle, the end of the file may be dipped as the cathode in the solution, and by increasing the pressure very materially cause the iron to heat up, lose its temper, and finally attain a temperature sufficiently high to be worked upon an anvil. Suppose now, that the file be used upon brass or copper, or lead, which will soon clog it up and render it useless. The freeing of the teeth may be quickly and conveniently done by placing it as the anode in a solution which will dissolve the foreign metal, without toching the steel of the file.

LETTERS TO THE EDITORS.

Induction Motors for Electric Traction.

To the Editors of Electrical World and Engineer:

Sirs:—I have read with much interest the discussion in the columns of your journal on the application of induction motors to electric traction. In 1892 I had constructed for experimental purposes a three-phase motor of 60-hp, intended for mounting directly on the shaft of one of my locomotives. This type was abandoned for the reason that it could not be applied to my special system of traction, but it furnished an opportunity for numerous experiments, which lead to the conclusion that the type is perfectly applicable for ordinary railway use. The motor had a short-circuited rotor and was tried at a frequency of 40. It gave very easily a starting torque of 770 pounds at the circumference of a wheel three feet four inches in diameter. As to any difficulty from small air gap, in this case it did not exist, as the air gap was greater than one-eighth inch. It is evident that this air gap could have been reduced with advantage, without interfering in any respect with security from the mechanical point of view. J. J. HEILMANN.

PARIS, FRANCE.

Rationalization of Electrical Units.

To the Editors of Electrical World and Engineer:

In view of the approaching International Congress of Electricians the article by Prof. Fessenden on "A Proposed System of Units,"* and the abstract from the article by Prof. Fleming on the same subject are of great interest. The trouble with the legalized system of units is due to the old theory of action at a distance and to the circumstance that the system was defined and adopted before the new theory of the action of the intervening medium was sufficiently studied. It was proved by Coulomb that the force between two small charged spheres is directly proportional to each of the charges and inversely proportional to the square of the distance between them. He proved that f varies as $\frac{q\,q^1}{r^2}$ and as the medium was never thought of, this was assumed to give

$$f = \frac{q\,q}{r^2}.$$

Similarly for magnetic poles, it was established experimentally that the force varies directly as each pole, and inversely as the square of the distance between them. It was proved that f varies as $\frac{m\,m^1}{r^2}$, and this was assumed to mean

$$f = \frac{m\,m^1}{r^2}.$$

These turn out not to be exact equations, and a system of units cannot be founded on anything but exact equations. All the fundamental relations on which the system is based must be expressed exactly and in perfect logical harmony with one another, otherwise the defects and discrepancies will soon manifest themselves. Rational investigation has now shown that in the former case the relation is exactly expressed by

$$f = \frac{1}{4\,\pi\,c}\,\frac{q\,q^1}{r^2}$$

where c denotes the specific inductive capacity of the medium, and in the latter case by

$$f = \frac{1}{4\,\pi\,\mu}\,\frac{m\,m^1}{r^2},$$

where μ denotes the permeability of the medium.

In his proposed system Mr. Heaviside derives the unit of quantity of electricity and the unit of quantity of magnetism by means of the more rational equations

$$f = \frac{1}{4\,\pi}\,\frac{q\,q^1}{r^2} \text{ and } f = \frac{1}{4\,\pi}\,\frac{m\,m^1}{r^2}.$$

It will be observed that he supposes both c and μ to be unity, and

*ELECTRICAL WORLD AND ENGINEER, Feb. 24.

thus introduces into the definition the properties of some standard medium. Whether the medium is air or ether is not plain; and, as Prof. Fessenden shows, there is conflict of opinion on the point. It seems to me that our present knowledge about the properties of the medium does not warrant the making of a change which completely upsets the present system and assumes a finality of knowledge about these properties which does not exist. It is very desirable that the student of electrical science should be saved from the conundrums due to the element of empiricism in the system of units, but not at the expense of a revolution.

It seems to me that Prof. Fessenden's proposal is an ingenious solution of the difficulty. To the standard medium chosen he assigns a specific inductive capacity $\frac{1}{4}\pi$, and a permeability of 4π, which stand to each other in proper physical relationship. They are as valid and logical assumptions as Heaviside's assumption that $c = 1$ and $\mu = 1$. By these assumptions the defining equations are reduced to

$$f = \frac{q\,q^1}{r^2} \text{ and } f = \frac{1}{(4\pi)^2}\,\frac{m\,m^1}{r^2}.$$

The former gives the existing unit of quantity and the latter gives the magnetic line which is a unit of quantity of magnetism in actual use, and which stands in rational relationship to the unit of quantity. The Coulomb and the Henry stand in decimal relationship to these units. Rationalization would be accomplished without revolution, and the way would remain as open as before to make any improvement in the future suggested by more exact knowledge.

LEHIGH UNIVERSITY. ALEXANDER MACFARLANE.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

By CARL HERING.

DYNAMOS, MOTORS AND TRANSFORMERS.

Open and Enclosed Motors.—LEVEN.—A general comparison. As it is more exposed, the open motor receives better attention, though the enclosed motor needs it the most. The enclosed motor should unconditionally have carbon brushes to prevent the formation of copper dust between the commutator segments, preferably radial brush holders, and on no consideration should tangent brush holders with copper brushes be used.—Lond. *Elec. Rev.,* March 9.

REFERENCES.

Dynamo Tests.—WAGNER.—An illustrated description of the tests made in the electric station of Zuerich with the new boilers, steam engines, alternators and motor generators, in order to ascertain whether the guaranteed requirements are fulfilled.—*Elek. Zeit.,* Feb. 22.

Double Current Generators.—An illustrated description of a 600-kw double current generator, built by the Westinghouse Company for the Quebec, Montmorency & Charlevoix Railway, and of the six rotary converters built by the same company for the New York Third Avenue Railroad.—*Can. Elec. News,* March.

LIGHTS AND LIGHTING.

Incandescent Lamps.—STARK.—A continuation of his researches noticed in the Digest Sept. 23. He describes an experiment showing that the hot gases in the bulb of an incandescent lamp convey the current in part. These gas currents cause the aureole at the positive terminal, which can be best seen in high voltage lamps. This aureole appears only at the relatively cold positive conductor, connected to the end of the filament, and not at the filament itself, which is extremely hot and heats the surrounding gases so much that they lose the property of phosphorescence (see the abstract under phosphorescence of gases). He then discusses the age coating of incandescent lamps, which he thinks is produced by these gas currents, causing a disintegration of the carbon filament, mainly at its negative end. The same phenomenon is seen in tubes with metal electrodes, where the cathode is disintegrated by electric discharges and the glass walls of the tube, near the cathode, are covered with a fine film of the disintegrated metal. This explains why the negative end of the filament of a continuous current lamp becomes black sooner than the positive end, and why generally a filament burns out at the negative end. In high voltage lamps showing the aureole, the age coating appears quicker than in low voltage lamps.—*Elek. Zeit.,* Feb. 22.

Enclosed Arc Lamps.—DRAKE and GORHAM.—A communication criticising some statements in the paper of Sayers on arc lighting from 250 volt mains (Digest, March 17; the author's name in that abstract should have been Sayers and not Maclean). His experiments are said to have been based apparently on the old shadow test, which is well known to be impractical as far as results are concerned. For practical results, reference is made to America. "There it has been clearly shown that the enclosed arc has not only replaced the open arc lamp in many important places, but that the fresh orders that have been placed have been almost entirely for enclosed arcs." Their own factory hands preferred the enclosed arc, as it gives better light with the same total watts. The authors attribute this to the fact that the diffusion is much better, and that the color is different.—Lond. *Elec.,* March 9.

POWER.

Electrically Driven Jacks.—A short article on the introduction of mechanical power instead of hand labor for traveling cranes in the locomotive works at Niappes. Compressed air as well as electric power, was available at the plant, and both were tried, but it was found by comparison with the electrical gear that the compressed air gear was complicated, and the cost of compressed air used was greater than that of the electrical energy consumed. The 5-hp electric motor and the necessary resistances are contained in a small car mounted on three wheels. The speed of the electric motor can be varied from 300 to 720 revolutions per minute by the introduction of resistances in the main circuit, and by altering the shunt resistance the speed can be further varied between 720 and 1035 revolutions per minute. The power yielded at the lower speeds is considerably reduced, but this is not a drawback, as the low speed is used when lowering the locomotive, and when but little power is required. An estimate of the relative cost of operation by hand labor and electricity is given, and it is found that if a fair value for interest and depreciation on the capital outlay is assumed, the saving effected by electric power is nearly $2.50 for one lift and descent.—Lond. *Elec. Rev.,* March 2.

REFERENCES.

Refuse Destruction.—An article stating that the Bermondsey municipality has now settled the question of the refuse destructor to be used in conjunction with the electric lighting station. An analysis is given of seven tenders for a six-cell destructor to destroy 50 tons of ashbin refuse in a working day of 22 hours.—Lond. *Elec. Rev.,* March 2.

TRACTION.

Tramway Statistics for Europe.—A table giving the statistics up to July 1, 1899, for 15 different countries. The following are some of the data for the principal countries. Germany 170 lines, 3457-km in length; England and Ireland 51 lines and 760-km; Austria 40 lines, 639-km; France 41 lines and 427-km; Hungary 16 lines and 323-km; Italy 23 lines and 459-km; Russia 15 lines and 214-km; Switzerland 36 lines and 266-km. The totals are 429 lines and 7131-km; 385 of the lines use the overhead conductor, 17 underground conductors, 18 accumulators and 9 the mixed system, 6 of which are in Germany; the total number of motor cars is 11,136 and the number of locomotives 71. A small table is also given in the same issue containing the lengths of lines for the preceding three years.—*L'Elec.,* March 3.

Testing Rail Bonding.—NISSLEY.—A diagram showing a differential method of testing rail bonding, which he has used successfully in practice. He recommends plotting the results graphically and to construct a map of curves showing all the electrical track conditions. Every electric railway company should make careful observations and measurements at the power stations for the determination of the existing conditions of the ground return in these stations. In many cases an outlay for additional copper for the return circuit would

pay. His investigation of the present system of using the rails for return circuit shows that the cross-section of the rails is sometimes insufficient to bring the current in without excessive drop.—*St. R'y Rev.*, March.

Peekskill Tramways.—An illustrated article on the electric equipment of the tramways of Peekskill, N. Y. The road is five miles long and has a constant grade, varying from 1 to 8 per cent. The power is furnished from the lighting company by a 60-kw continuous current dynamo, a differential booster, and a battery of 262 chloride accumulator with a capacity of 40-amp. for 7 hours.—*Elec. Rev.*, March 14.

REFERENCES.

Boston.—FAIRCHILD.—The first part of a well illustrated description of the system of the Boston Elevated Railway Company.—*St. R'y Rev.*, March.

Vienna Pressburg Railway.—A long English abstract of the German article noticed in the Digest Feb. 24.—Lond. *Elec. Eng.*, March 2.

Newtown.—An illustrated description of the three-phase transmission system, with synchronous converter substations, of the Newtown, Pa., electric street railway.—*St. R'y Rev.*, March.

Brooklyn Heights Railroad.—An illustrated article, describing the Fifty-second Street and Eastern Power stations and the arrangements of the boosters for the Sea Beach line.—*Railr. Gaz.*, March 16.

Coventry.—An illustrated article on the electric tramways of Coventry, England (Digest, March 3, 10).—*St. R'y Rev.*, March.

Convention.—A programme of the annual convention of the International Tramway Association to be held in Paris in September. A list of the subjects of the papers is given.—*St. R'y Jour.*, March.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

The Choking Coil for Lightning Arresters.—An algebraic discussion of the value of the choking coil in protecting electrical machinery from a discharge, and the effect of the coil during electrical charge. The expression for the combined impedance of the coil and the machine, for the case of a lightning discharge is given, and is shown to be a rectangular hyperbola with one asymptote parallel to the impedance and the other perpendicular to it. When the reactance of the choking coil is small, the change in the combined impedance is nearly proportional to the change in the reactance of the choking coil, but as the latter increases, the value of the impedance approaches the asymptote which is perpendicular to the impedance and decreases the effect of the reactance of the coil until it reaches the limit at which the impedance can no longer be increased by increasing the reactance of the coil; this means that the effect of the choking coil cannot be increased beyond a certain limit by increasing its reactance. In the usual case, in which the self-induction of the machine is large, compared to that of the choking coil, the effect of that coil is of comparatively little importance and the coil is therefore a poor device to use for protecting a machine from a lightning discharge. The effect of the coil during the charging strain is also shown to be too small; the necessary requirement in that case is the retardation of the time of charge, that is, the time of oscillation; the choking coil is of small importance for this purpose as compared with the effect of the whole circuit. Moreover the reactance of the coil is of little significance as a protection of the machine from the charging current in the usual cases. He concludes that the choking coil is therefore practically useless for both purposes. But in order to reduce the strain on the part to be protected to a minimum, a certain inductance is required, depending on the frequency of oscillation, and to get this inductance of the whole circuit a choking coil can be used to advantage in the circuit.—*Elec. Friend* (Japan), Dec. 15.

Balancing Sets.—WIGHTMAN.—An article, chiefly mathematical, giving some notes on the function and design of a balancing set, which, in a three-wire system, has to balance any want of equality between the loads on the two sides of the system and also to drive one or two boosters. He considers a balancer consisting of two identical dynamos having their armatures coupled together, and develops a value for the maximum current which each armature must be designed to carry, when balancing only, and then when one or two boosters are coupled to the balancer. When only balancing is required, so far as the current i, driving the set is concerned, the two balancer armatures may be regarded as one motor armature connected across the outer wires. In addition to i, an extra motor current is required to drive the boosters. Although the current in the middle wire may remain constant, the current through the dynamo side of the balancer is reduced as more and more load is put on the boosters, until it becomes zero. If still more output is required from the boosters, both sides of the balancer become motors, one side, however, doing much more work than the other.—Lond. *Elec. Rev.*, March 2.

London Electric Plant.—The first part of a very long well illustrated description of the new Willesden station of the Metropolitan Electric Supply Company in London. The system used before the starting of the new plant was an alternating current transformer system at 1000 volts high pressure and 100 volts low pressure. There were four generating stations, the plant capacity being equivalent to 350,000 lamps of 8-cp in 1897. The connection of lamps at present is 500,000. The plant in Willesden generates current at 10,000 volts two-phase for transmission to London and transforming down at the existing generating stations. The company intends to replace alternating current distribution by continuous current, utilizing motor generators to effect this conversion. An independent concentric cable is used for each phase of the two-phase system; the outer conductor of each cable is earthed. The buildings, the coal transporter, the boiler house and engine house are described in detail. There are three Westinghouse machines, each of 1500-kw, the pressure of each phase being 500 volts. The voltage is raised for transmission. There is a battery of 124 cells with a capacity of 1000 amp.-hours; it is charged by a small auxiliary plant and is connected to the auxiliary terminals of the field switches of the alternators.—Lond. *Elec., Elec. Eng.*, March 9; *Lightning*, March 8. Also ELECTRICAL WORLD AND ENGINEER, Feb. 3, 1900.

Continuous Current Plants.—A large table giving a list of the low and high pressure, continuous current plants of the United Kingdom, giving in 26 columns much valuable information. There are 78 provincial and 11 London low pressure plants. In by far the most of them the pressure at the consumer's terminals is between 200 and 250. The actual capacity varies between 8137 and 22-kw. There are 10 provincial and two London high pressure plants. The pressures at the consumers' terminals is 220 in two plants, both 110 to 115 and 220 to 230 in three plants, 150 in one, and 100 to 105 in three, the remaining three stations supply current only for street lighting.—Lond. *Elec. Rev.*, March 2.

REFERENCES.

Electric Bells.—An illustrated communication describing a method of installing electric bells on a 110-volt electric circuit.—*Can. Elec. News*, March.

Continuous Current Series System.—CUENOD.—His long well illustrated paper on the Thury system in full, an abstract of which was noticed in the Digest Feb. 24.—*Bull. de la Soc. Int. des Elec.*, January.

Hospital Plant.—A brief illustrated description of the electric lighting and power plant of the Victoria Hospital, London, Ont.—*Can. Elec. News*, March.

Central Stations.—PEACH.—The first part of a lecture on the design and construction of electric central stations from the point of view of an architect.—Lond. *Elec. Eng.*, March 2.

Electricity in Country Houses.—Some illustrations, with short descriptions, reprinted from a pamphlet.—Lond. *Elec. Eng.*, March 9.

Maximum Demand System.—MAYCOOK.—A description and discussion of this system of charging for electrical energy.—Lond. *Elec. Rev.*, March 2.

Electric Standardization.—An abstract of the continuation of the discussion of Sellon's Brit. Inst. E. E. paper (Digest, March 3, 17).—Lond. *Elec. Eng., Elec., Rev., Elec.*, March 2.

WIRES, WIRING AND CONDUITS.

REFERENCES.

Cleaning and Reinsulating Wire.—An illustrated description of a machine, devised by Henninger, of the Detroit Citizens' Street Railway Co. Wire, the insulation of which has been injured, is stripped and reinsulated ready to be again used. The machine has been in practical use and is said to have greatly reduced the cost of motor repairs on that road. They use a special tape made exclusively for that purpose, which is said to be a better insulation and to last longer than ordinary cotton fibre, and to be less easily displaced, and being interwoven it is more rigid and durable.—*St. R'y Rev.*, March.

Cable Breakdowns.—KAPP.—The first part of an illustrated English translation of the German article, abstracted in the Digest Jan. 20.—Lond. *Elec. Rev.*, March 9.

ELECTRO-PHYSICS AND MAGNETISM.

Electromagnetic Theory.—HEAVISIDE.—The 112th continuation of his serial, forming the first part of his third volume. He points out that it would be perfectly practical to begin the serious development of a theory of electromagnetism not with electrostatics, but with electromagnetic waves of the "easy kind." He first proves the fundamental property of a plane wave, that it travels at constant speed undistorted, if there be no conductivity, or, more generally, no molecular interference causing dispersion and other disturbances, and then considers how to generate plane waves by impressed electric or magnetic force.—Lond. *Elec.*, Feb. 23.

Electrification and Surface Tension of Water and Mercury.—MERRITT and BARNETT.—A paper pointing out that while the electrocapillary phenomena occurring at the interface between a liquid metal and an electrolyte, as in a capillary electrometer, are due almost entirely to true alterations of surface tension resulting from the chemical changes of electrolysis, there are many other electrocapillary phenomena which are undoubtedly caused largely, if not wholly, by the electrostatic forces that are developed by the presence of a charge upon the liquid surface, as in the expansion of an electrified soap bubble. In such cases the effect of electrification is usually similar to that which would be produced by a diminution of the surface tension. In a former paper, Barnett had investigated with a new method, whether in addition to this electrostatic effect there exists a true effect of electrification upon the surface tension, and found that if it exists at all, it is much smaller than previously supposed. In the present paper the theory of that method is completed and the conclusion is reached that the complete investigation, while not excluding the possibility of discovering an effect of electrification upon surface tension by the use of improved methods and still more intense charges—does not itself give any support to the view that such an effect exists.—*Phys. Rev.*, February.

Thermoelectricity.—BARRETT.—An account of experiments with a particular nickel steel, consisting of 68.8 per cent. iron, 25 nickel, 5 manganese, 1.2 carbon. The specific electric resistance is 97.52 microhms per cb.cm.; the temperature coefficient between 0° and 250° C. is 0.08 per cent. per degree. Wires of this alloy were coupled to iron wires and the thermoelectric force was measured, when the cool junctions were kept in ice and the other junctions were heated to a white heat. The thermoelectric force rose rapidly until a certain temperature much below redness was reached, and then remained almost stationary, notwithstanding that the temperature of the junction rose from a black up to a bright, white heat; i. e., the change in the thermoelectric force is arrested when a certain temperature is reached, and the force remains nearly the same in spite of the increasing temperature; this is shown in a diagram. With an ordinary mild steel wire instead of iron as the second metal, the e. m. f. is less, remains constant only between 400° and 600° C., and then continually falls. With platinum and copper as second metal no such singular constancy of e. m. f. through a wide range of temperature was observed.—*Phil. Mag.*, March.

Discharge of Electricity Through Argon and Helium.—STRUTT.—An illustrated paper giving an account of measurements of the cathode fall of potential in helium and argon, of experiments with electrodeless discharges, and of measurements of the conductivity of helium under Röntgen rays. He concludes the paper with the following general remarks. The peculiar interest of the gases argon and helium is in their monatomic characters. The view is now generally taken that the electric discharge is conveyed in all cases by ions, these ions being produced by a dissociation process of some kind. If this be admitted, there can be no escape from the conclusion that the ions of monatomic gases are split up into something smaller. His experiments make it sufficiently clear that these gases convey the discharge in a normal manner. If the potential fall at the cathode is a measure of the energy expended in the ionization of the gas, when affected by an electric field, the experiments show that the ionization of argon and helium is somewhat more easily effected than that of other gases. There are other reasons for thinking that the atomicity of an elementary gas is not an important factor in its facility of ionization. Thus mercury vapor conducts more freely than air under the influence of Röntgen rays; helium, on the other hand, only about half as well as air. There is one peculiarity which seems to belong to monatomic gases only: that only in such gases do aluminum cathodes "splutter." This, however, is a subsidiary point and cannot be interpreted so far.—*Phil. Mag.*, March.

Spark Discharges.—RUHMER.—An illustrated description of a peculiar form of spark discharges between a positive point and a negative disc, using a Wehnelt interrupter. For a certain distance of the point and the disc, many thin bright sparks are starting from the point and travel on diverging, sinusoidal paths to the disc. He shows that the simultaneous traveling of many sparks is only apparent and that at one time only one spark is going from the point to the disc, the discharges following each other very rapidly.—*Elek. Zeit.*, Feb. 22.

Brush Lights Emanating from Kite Sustained Wire.—EDDY.—A communication in which he says that the high voltage of the atmospheric electricity, with which he is working by means of kites, results in a remarkable display of brush light at night from every splice which has been made in the wire. The light becomes more vivid at the earth if a grounded iron rod is made to approach the spliced wire. "This atmospheric electricity has little motive power, and scarcely any magnetic effect. I have a very small electric motor which runs with one Leclanché cell, but the sky electricity has so little magnetic power that the motor will not stir even when subjected to possibly millions of volts at high tension static electricity." —*Elec. Rev.*, March 7.

Phosphorescence of Gases.—STARK.—An account of an investigation of the phenomenon of luminosity of vacuum tubes. He introduced white-hot carbon filaments into the tube at various points, and kept the current constant. If the filament is in the region of the positive light, it reduces or extinguishes the light. If it is stratified, the filament cuts pieces out of the bright strata. A short positive column is totally extinguished by the filament. The negative light is enfeebled, but the luminescence of the walls is unaffected, thus showing that the cathode rays are not influenced by the presence of the hot body. The heating simply deprives the gas of its power of phosphorescence under electric discharge. As a rarefied gas is ionized by heating, it is to be concluded that an ionized gas does not phosphoresce under the influence of the electric discharge, which indicates that phosphorescence is a molecular rather than atomic phenomenon.—*Ann. der Physik*, February; abstracted in Lond. *Elec.*, March 2.

Generalized Cathode Rays.—SAGNAC.—A French Academy note in which he endeavors to bridge the gap between ionized air molecules and cathode rays by the following considerations. Let the gold leaf of an electroscope be charged positively, and let the electroscope be divided by a metallic net from a space traversed by Röntgen rays and placed under the influence of another electrostatic field. Then the discharge of the gold leaf which takes place in the absence of any external field, is accelerated or retarded accordingly as the external and internal fields are of the same or opposite directions. This acceleration or retardation is not due to the mere presence of the external field, since that field produces no effect unless the X-rays are traversing it. Hence it must be due to some action of the ionized molecules which penetrate into the interior of the electroscope through the meshes of the net. If they have sufficient velocity on passing the mesh, they will skip over from an external to an internal line of force, and thus increase or decrease the internal flux which is slowly discharging the gold leaf. This is another case of bombardment by charged particles which, on gradually reducing the pressure of the air and thus increasing their velocity, might be made to pass by insensible gradations into cathode rays.—*Comptes Rendus*, Feb. 5; abstracted in Lond. *Elec.*, March 2.

Becquerel Rays.—BECQUEREL.—A French Academy paper giving an account of experiments in which he studied the dispersion of Becquerel rays by the photographic method. A scientific definition of the position of each ray in the "magnetic spectrum" is obtained by taking the product of the field into its radius of curvature. The product is constant for each ray, and varies from 360 to 2600 c. g. s. units.—*Comptes Rendus*, Feb. 12; abstracted in Lond. *Elec.*, March 2.

REFERENCES.

Nature of Stratified Discharges.—PELLAT.—A French Academy note giving some new and decisive reasons why the stratifications observed in vacuum tubes cannot be attributed to the interference of some kind of direct and reflected waves.—*Comptes Rendus*, Feb. 5; abstracted in Lond. *Elec.*, March 2.

Striated Electric Discharge.—JEANS.—An illustrated paper, chiefly mathematical, on the appearance of light which accompanies the discharge of electricity through a rarefied gas. He attempts to show that J. J. Thomson's theory of the conduction of electricity through gases by charged ions, is capable of supplying an explanation of the striations, and of most of the other phenomena observed in connection with the discharge through a vacuum tube.—*Phil. Mag.*, March.

Becquerel Rays.—An illustrated summary of the present knowledge on Becquerel rays.—Lond. *Elec. Rev.*, March 9.

Electro-Chemistry and Batteries.

Tobiansky Accumulator.—Foresio.—A brief description of this accumulator which he speaks of very highly but does not describe in detail. The usual grid is replaced by a tissue of wire made of an alloy having a specific gravity of 3.10 and is not attacked by acids; the active material is contained in the meshes. For one kilogram of plates he obtains 20 to 25 ampere-hours capacity as compared with 10 ampere-hours of the usual accumulators; the capacity is therefore double that usually obtained. In one kilogram of plates the metallic tissue weighs only 200 to 250 grams, while the active material weighs 700 to 750. The electrodes are said to be quite strong and will stand being bent without injury. There is a large residual discharge. This is about all the technical information given; the terms amperes and ampere-hours are used apparently incorrectly.—*L'Elec.*, Feb. 24.

Electrodeposition.—Tommasina.—An account of experiments, in which he sent a current of less than a milliampere from a pointed anode to a flat cathode, both of zinc, through distilled water. Small brilliant flat triangular and rhombic crystals were rapidly deposited upon the cathode, and at the same time there was an evolution of gas. Copper gives a black arborescent deposit, while silver gives an arborescent deposit of less intense metallic lustre than zinc. Aluminum gives no metallic deposit, but an arborescent structure of gas bubbles is formed. When the distance between the electrodes is increased beyond a certain point, a fine column of minute crystals or corpuscles descends from the anode upon the cathode. This is especially noticeable in vaseline oil. This column is flexible and is deflected in a direction which does not change with a reversal of the current. It is deflected away from the rest of the circuit, owing to electrodynamic repulsion.—*Comptes Rendus*, Feb. 5; abstracted in Lond. *Elec.*, March 2.

Electroplating.—A note on a proposal of Dr. Courant to overcome the trouble experienced in the use of baths containing potassium cyanide for electroplating. He proposes to use for that purpose triple cyanide salts, for which he claims great stability and that it is only necessary to dissolve them in water to furnish the requisite bath. The triple copper salt is prepared by dissolving pure cuprous oxide in potassium cyanide, with the formation of a compound which is treated "with just sufficient sulphurous acid accurately to saturate" the potash contained in it. By this means a triple salt is obtained which is most stable and forms, when dissolved in water, a copper electrolyte of remarkable purity and great conductivity. In like manner the triple salts of gold, silver, nickel and zinc may be produced. Bronze and brass baths, which will give a deposit of any required shade of color, may be obtained by suitably mixing the solutions of the copper and zinc triple solutions. These triple salts are claimed to enable one to easily control the amount of metal in the baths. Old baths can be readily regenerated.—Lond. *Elec.*, March 9.

REFERENCE.

Reversibility of Galvanic Cells.—Moore.—A brief abstract of a British Physical Society paper describing experiments in which he tested the reversibility of cells such as the Daniell and the Clark, which are assumed to be reversible, by allowing the cell to send a current and by sending a current through the cell. The e. m. fs. of the cells were determined by means of a potentiometer, and from the e. m. fs. on open and closed circuits the internal resistances of the cells were calculated.—Lond. *Elec., Elec. Eng.*, March 9.

Units, Measurements and Instruments.

Magnetic Observatories and Electric Railways.—Bezold.—A paper read before the Electrotechnical Society of Berlin on the investigation made by Eschenhagen and Edler in Potsdam on the influence of electric tramways on measurements of terrestrial magnetism. He called attention to the fact the first development of electrical engineering can be traced to observatories of terrestrial magnetism, and that now the existence of the latter is endangered by the influence of the return currents of electric tramways, where the rails are used for the return circuit. The work at the observatories of Washington, Toronto, Vienna, Nizza, Copenhagen and Batavia has been stopped completely; great troubles are experienced in Greenwich; Pola and Parc St. Maur, near Paris, appear also to be doomed. He points out the extreme importance of measurements of terrestrial magnetism for navigation. In North America at present a large reorganization of the work of terrestrial magnetism is in progress, not only in the interest of navigation, but because in America the boundaries of the states and counties were formerly designated by the compass, which accounts for the straight lines which appear on American maps; the continuous variations of terrestrial magnetism may therefore become a cause of many legal difficulties. The methods now in use in the most modern observatories for measuring these variations, are discussed at some length, and it is pointed out that the exactness of the measurements in the observatory of Potsdam would be lost, if the projected extensions of the city tramways would be made; besides accumulator traction, there are no means but double conductors to prevent these results. He thinks that with a proper installation of overhead feeder and return conductor, magnetic influences may not be experienced in a distance of more than 0.6 mile. The discussion which followed, and in which Siemens and Dobrowolski participated, was concluded by the appointment of a committee of magnetic scientists and electrical engineers.—*Elek. Zeit.*, Feb. 22.

Standards of Light.—Petavel.—The first part of a Royal Society paper, in which he describes experimental researches on some standards of light. The standards of light may be divided into two main divisions: flame standards and incandescent standards. The standards of the first class depend for their constancy on the rate at which chemical combination in going on; almost all the standards in actual use come under this division. The Hartcourt pentane gas standard and the Hefner-Alteneck amyl acetate lamp have been found most satisfactory. The light emitted is, however, seriously affected by atmospheric impurities. This can be obviated by providing a chemically pure atmosphere, but that involves a considerable complication of the apparatus. The constancy of the light of incandescent standards depends essentially on the constancy of the temperature at which the radiating body is kept, and on the constancy of the emissivity of the body at that temperature. Most of the oxides when maintained at 1700° C. undergo a change in their emissive properties, and therefore cannot be used as standards, so that the choice thus seems restricted in practice either to carbon or to one of the metals of the platinum group. The fact that the area of the crater of an electric arc between carbon poles increases about in proportion to the current and that the light emitted increases in the same ratio as the area of the crater, led to the conclusion that the temperature of the crater remained constant. The hypothesis was put forward that this temperature is the boiling point of carbon, and it has been proposed that the crater of the arc should be used as a standard of light. He investigated the variation of the intrinsic brilliancy of the crater, the arrangement of his experiments being described and illustrated. He found that the intrinsic brilliancy of the crater of a silent arc is about 147-cp per square millimeter. Even when the most favorable conditions are selected, and the intensity of the current and the length of the arc are maintained constant, it is difficult to obtain consistent results, variations of over 5 per cent. being by no means infrequent. The crater of the arc therefore does not possess the qualities required of a standard. Variations in the size of the carbons, in the intensity and density of the current, in the length of the arc, and in the total power expended, as long as the arc is kept silent, do not cause the intrinsic brilliancy to vary more than 10 per cent. on either side of the mean. No sensible variation in the intrinsic brilliancy, and therefore in the temperature of the crater, is produced by placing the carbons in an enclosure maintained at over 900° C. He then determined the effects of extreme variations of current density and power and gives in two tables the results of observations taken when the arc was hissing. When the current varied from 6 to 50-amp., the current density from 0.03 to 0.51-amp. per sq.mm., and the power from 370 to 2800 watts, the lowest photometric readings gave 119-cp and the highest 160-cp per sq-mm. Taking everything into consideration, he says that his experiments confirm the theory that the crater of the arc is at the temperature of volatilization of carbon.—Lond. *Elec.*, March 9.

Moving Coil Instruments.—An illustrated article taken from a catalogue of Evershed and Vignoles. The advantages of the moving coil type are, that the instrument is easily made perfectly aperiodic by winding the coil on a copper former; that a uniform magnetic field and a spring control give a scale of equal divisions over the whole range; that there are no errors due to hysteresis; and that when used as a voltmeter for any pressure above about 2 volts, there are practically no temperature errors. The difficulties in construction are the following: the moving parts are much heavier than those of a soft iron instrument, so that friction errors are probable; the mechanism is rather complicated and there is a liability to failure from rough usage; when used as ammeter considerable temperature errors

are possible; the spring control for leading the current to and from the moving coil is liable to effects of fatigue; the indications are only trustworthy so long as the magnet retains its original strength. The Evershed moving coil instruments are described and illustrated. The permanent magnet with soft iron pole-pieces is fixed permanently to a brass framework. The complete magnetic circuit so formed is then magnetized and "brought into a condition of permanence by a process which leaves every magnetic molecule in the circuit in a position of stable equilibrium;" this process is not described. The moving coil has two parallel rectangular sides adapted to move in the airgaps of the magnetic circuit, the two sides being joined at one end by a straight cross-piece through which the axle passes, and at the other end by a circular ring-piece which enables the coil to be inserted without taking the magnetic circuit to pieces. A magnetic shield is fitted to the dial pattern moving coil ammeters and voltmeters, and obviates the necessity for closing in the dial by a cast-iron cover plate. The moving coil in the voltmeters consists of many turns of fine copper wire connected in series with a high resistance wire wound in a single layer on one or more porcelain tubes. This series resistance is made of a material with a negligible temperature coefficient, and as its resistance is generally hundreds of times that of the moving coil itself, the temperature coefficient of the instrument as a whole is practically zero. The moving coil of the ammeters consists of a few turns of thick copper wire, connected in series with the two leading in strips, and a series resistance made of the same alloy as is used for the resistance of the voltmeters. This resistance is adjusted until the potential difference on the ammeter terminals, when the latter are connected across a shunt through which the main current passes, deflects the index to the required point on the scale. The temperature variation may be reduced to any value by increasing the series resistance, but the instrument then requires a higher potential difference to work it. The makers have adopted as a value for this drop of volts a "reasonable compromise." The ammeter shunt is also described and illustrated.—Lond. *Elec.*, March 2.

Measuring Instruments in High Tension Plants.—WIDMANN.—An illustrated communication criticising the method of Schueler (Digest, Jan. 6), the drawback of which he thinks is the fact that the ratio of the e. m. f. of a part of the armature winding and the whole e. m. f. of the machine is not a constant. He agrees that the method of Schueler is very simple and not dangerous, but the same results may be obtained, if with the aid of small auxiliary transformers both the machine e. m. f. and the machine current are transformed down. Such an arrangement is described and illustrated by a diagram.—*Elek. Zeit.*, Feb. 22.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Tramway Return Currents and Submarine Telegraphy.—JAMIESON.—The complete illustrated paper, the first part of which was abstracted in the Digest March 17. He discusses the various probable actions of the tramway currents on the submarine cables. The action of electrolysis has no effect in the case in question, nor is there a supposed action of electric stray currents from the tramway system which more of less continuously alters the potential of the receiving instrument's earth connection. He also doubts whether the chief cause of the observed disturbances can be attributed to what he calls direct electromagnetic induction, i. e., an "effect which would be directly, or at first hand, communicated to the insulated conductor of the submarine or underground cables from the erratic currents passing along the trolley wires in one direction and returning by the rails." The disturbances are mainly due to leakage or stray return currents from the tramway rails. They find a ready path to and along the heavy low-resistance sheathing of the submarine cable on their way back to the power house, and in doing so they produce by induction correspondingly erratic currents in the cable conductor, which of necessity interfere with the weak receiving currents during their arrival at the Cape telegraph office. He then describes the anti-inductive earthing cables laid by the Eastern Telegraph Company. A short cable of about five nauts was laid in 1897 as nearly as possible over the shore end of their main cable and connected to the earth side of the telegraph office recorder by means of a second underground cable inserted in another cast-iron pipe which lay parallel and close to the first pipe and cable. The sea end of the conductor of this short cable was earthed by soldering it to its sheathing, the soldered joint being protected from the sea water. As long as the tramway traffic remained light, this was sufficient to neutralize all inductive effects. After the extension of the tramways took place, it became necessary to lay another cable of 11 nauts, in a similar manner and earth it at Robben Island. But even then disturbances were observed. He then mentions previous anti-induction earthing cables laid at Madras and at Coney Island. He proposed to the Commission the following remedies for induction and stray current interferences. A symmetrically arranged and specially made twin twisted core with double armoring should be used for the shore end and it would not require to be more than from two to three nauts. One core of this special cable would require to be jointed to the core of the main cable in the bay, the sheathings thoroughly well spliced together, and the conductor of the second core soldered to the outer sheathing of the main cable, and there sealed from the sea water. The ends of these two cores at the cable hut would require to be connected to corresponding ends of an armored "doubletwisted core" encased in one thick cast-iron pipe placed underground between the cable hut and the telegraph office, and the conductors connected to the signaling condensers and the receiving instrument. He further recommended the tramway company to obtain and place in circuit, together with separate return feeders from different points along the rails, a sufficient number of negative boosters or sucking dynamos. Finally he believes that land telegraph, telephone and other electric circuits can be protected from all interfering influences of electric tramways by using twisted forward and return insulated conductors, and that electrolysis may be prevented by using heavy, well-bonded rails with return feeders and sucking dynamos, whenever the fall of pressure along any section tends to exceed 5 volts. The paper is also commented upon in an editorial.—Lond. *Elec.*, March 2.

Underground Telegraph and Telephone Work.—An illustrated article on the underground work of the Illinois Telephone & Telegraph Company in Chicago. Under the centre of the streets in the business district of the city there is a system of tunnels. Upon racks on the sides of these tunnels the company proposes to carry all of its wires and cables, its distributing system being carried through laterals running from the tunnels to the building line, and then rising to the surface under the sidewalk. In this way all manholes in the streets are to be avoided.—*West. Elec.*, March 17.

Development of Telegraphy in Japan.—A historical description, supplementing similar descriptions of the electric power plants and the telephone, in that country, which were given in previous issues of that journal. The first telegraph instrument introduced into that country was of the Morse type, presented by the American ambassador to the Shogun government in 1851; the first practical telegraph line was constructed in 1870, and was considered a very wonderful thing by the inhabitants. From that time on, the development was extremely rapid, especially during the past ten years; it is shown from the following data: in 1870 the total length of lines in miles was 0.54; ten years later it was 9850 and the number of massages 2,041,372; in 1887 there were 15,150 miles of lines and 5,064,552 messages; in 1898, 46,328 miles and 14,296,378 messages. The telegraph is controlled by the government like all other systems of communication. The system and instruments used at present are the Wheatstone automatic recorder, the duplex and the quadruplex systems and many of the newer systems, such as wireless telegraphy. The instruments are made almost entirely at the government factory in Tokyo and involve some improvements on those used in other countries.—*Elec. Friend* (Japan), November, 1899.

Wireless Telegraphy.—An editorial on the commercial possibilities of wireless telegraphy. Doubt is expressed whether it is likely to be used to a sufficient extent in Great Britain to permit the payment of dividends by the Wireless Telegraph Company for a long time to come. If this company were to make apparatus to sell to all comers the probability is that they would do a large business, but they do not care to supply apparatus unless they supply a supervisor with it. The later experiments in wireless telegraphy tend to show that one of its most useful spheres of operation is a maritime one.—Lond. *Elec. Rev.*, March 2.

Wireless Telegraphy.—An editorial referring to a recent speech of Major Page, of the Wireless Telegraph & Signal Company. It is pointed out that there is one hitherto insuperable barrier in the way of the general spread of the Marconi system, namely, the interference that must exist between the individual instruments in a group of stations. The recent speeches of Marconi and Page did not refer to it at all.—Lond. *Elec.*, March 9.

REFERENCES.

Statistics.—A statistic table, taken from the *Jour. Telegraphique*, for telegraphy in 1898. It is not quite complete; the United States

and some other countries are not included. The statistical results are also discussed in an editorial.—*Elek. Zeit.*, Feb. 22.

Submarine Cables.—LEMIRE.—An article on the cables owned by England, with respect to the French colonial possessions.—*Dépêche Coloniale*; abstracted at some length in *L'Elec.*, March 3.

Toll Lines.—WINFIELD.—An illustrated article in which, after a general introduction on some of the factors entering into the problem of transmitting speech over long distances, he discusses the mechanical features of the line, the lightning protection and the repeating coil.—*Tel. Mag.*, February.

Interurban Telephone Switchboard.—PIERARD.—A short illustrated description of a switchboard for metallic circuits.—*L'Elec.*, March 3.

Michigan.—WARE.—A statistical article on the progress of the independent telephone movement in Michigan during the last four years.—*West. Elec.*, March 17.

Independent Exchange.—A long article giving brief biographies, with portraits, of a large number of managers of independent telephones exchanges in the United States.—*West. Elec.*, March 17.

MISCELLANEOUS.

Electricity in Medical Practice.—JONES.—A long paper read before the Brit. Inst. of Elec. Eng. showing that electrical applications have a large and legitimate field of usefulness in medical practice. An important part of the work in the electrical department of the hospital is the testing and reporting upon cases of injury or disease of the various portions of the nervous system and the muscles, and the accuracy of the answers given by electrical testing is said to be very great. The behavior of a muscle under electrical stimulations by a simple shock or by a rapid succession of shocks is quite different; there is also a difference in the effect of direct and alternating currents. For electric treatment the fact is utilized that electricity is a stimulus to certain living tissues. It has been shown that the application of electricity to the central nervous system in the form of a continuous current along the spine undoubtedly increases the muscular power and that applications to the muscle of a limb had the same effect. General electrification applied to cases of simple failure of nutrition such as debility of any kind, produces a rapid improvement in the condition of the patient. In the field of paralytic conditions there are certain strict limitations to the utility of electric treatment; in some cases electricity is powerless to help. Electricity is useful in the relief of pain by influencing the circulation in the painful part and relieving congestion and pressure in the blood vessels. Electrolysis is useful as a means of destroying tissue; small tumors of various kinds can be very conveniently treated by electrolysis; metallic needles are introduced into the tumor and the products of electrolysis are thus liberated in contact with the tissue to be destroyed; so fine and so delicate an application can be made that the root of a single hair can be destroyed without leaving any visible scar. France is said to be in the lead now in medical electricity. He then describes the modern types of apparatus in common use, such as the electrodes, the battery, the induction coil, the use of current for the mains, the statical machine. The Leclanché type and dry cells are the best. Most of the surgeon's requirements are met by a portable accumulator of four cells. The strength of current used in treatment ranges generally between 4 and 40 milliamperes. The current impulses from the alternating electric light mains have a physiological action resembling those of the induction coil, but it is superior to the induction coil in being a less violent stimulus to nerve and muscle. There is one marked difference in the effect of the alternating current from the mains which limits its use and that is, that if applied in the ordinary way to the surface of the skin through moistened electrodes it has a peculiar disagreeable burning effect; the more the skin is moistened the less this is noticed, and when the current is conveyed to the patient through the medium of water, as in a bath, this disagreeable cutaneous effect disappears entirely; consequently a mode of treatment by means of baths and the sinusoidal current has been developed to a very considerable extent and with decided advantage to the patient. Large numbers of his cases are those of paralysis of the upper limb from injury or disease of the nerves of the upper extremities, and for this he uses an arm bath. For general morbid conditions he uses a large bath in which the whole of the body is immersed; the bath with direct current has also certain useful applications as for the relief of gout, rheumatism, sprains, chronic inflammations, etc. The arrangements of St. Bartholomew's Hospital are described. The statical machine now shows very decided signs of revival. In Great Britain the Wimshurst machine is in common use, but he thinks that the American improved Holtz machine gives a better output. Ozone in its medical applications is as it were waiting until some one has time to attend to it. The application of Röntgen rays to the diagnosis of diseases of the chest is said to be one of the most promising things for the future. Pulmonary consumption can be diagnosed by the Röntgen rays more satisfactorily and at an earlier stage than is possible with the stethoscope.—Lond. *Elec.*, March 9; reprinted in *El'ty*, March 21.

Electrical Engineering in the British Navy.—S. F. WALKER.—A communication replying to the question: "Why is electrical knowledge so small in our (British) navy?" He answers because the admiralty are pursuing the same time-honored course which they pursued with the medical and the marine engineering professions, and with the same results. The old feeling prevails that the executive officer still looks upon the engineer officer as of a lower caste. "Our American cousins, in their usual practical fashion, have grasped the situation at once, and Engineer-in-Chief Melville is now a commodore, the second highest rank in the American navy."—Lond. *Elec. Rev.*, March 9.

Annealing Armor Plates.—DOUGHERTY.—An illustrated reprint of the paper abstracted in the Digest March 24.—*Elec. Rev.*, March 14, and with fewer of the illustrations in *El'ty*, March 14.

A communication by Lemp answering the question brought out in the discussion of this paper. He states that choking coils had been shown in his paper read in 1895, above referred to, but the methods used of regulating the field of the alternator is much simpler and more economical than the use of a choking coil. Moreover the wires are then always dead, except when actual annealing was done. If more than one annealer is used the best arrangement is a rotary transformer operated from a 100-volt continuous current circuit mounted on a truck. His process has been adopted by the English, American and French navies.—Lond. Elec., Feb. 16.

Municipalities as Electrical Traders.—An article on the desire of some British municipalities to engage in trading, manufacturing, buying and selling. It is pointed out that municipal trading, outside of the reasonable limit of lighting, water supply and, in some cases, local transport, would, if allowed in its mildest form, prepare the way for developments upon the same socialistic lines "which would ultimately lead to nobody knows where"—Lond. *Elec. Rev.*, Feb. 23.

REFERENCES.

Aluminum Solder.—A short note stating that a solder for aluminum has recently been patented which is a composition of tin, zinc and bismuth, the largest constituent being tin.—Lond. *Elec. Eng.*, March 9.

Biographical.—KERR.—An account of the life and work of J. B. Lindsay, who is said to have used electric light in 1835 and to have made successful experiments with telegraphy without wires through water in 1854.—*Can. Elec. News*, March.

Mica.—SMITH.—An abstract of a paper read before the British Inst. of Mining and Metallurgy, on mica mining in Bengal, India.—*Austr. Min. Stand.*; reprinted in *El'ty*, March 14.

Velvril.—DELAHAYE.—A short article on this material which is intended to replace india rubber and gutta percha. The material has already been described in the Digest.—*L'Elec.*, March 3.

New Books.

POLYPHASE ELECTRIC CURRENTS AND ALTERNATE CURRENT MOTORS. By Silvanus P. Thompson. Second Edition. New York: Spon & Chamberlain. 508 pages, 351 illustration, 24 colored illustrations and 8 folding plates. Price, $5.00.

The announcement of this new edition of Prof. Thompson's well-known work states that it is a "new authorized American edition." This must not be taken to mean that there is much that is new from the American standpoint in the edition. In common with Prof. Thompson's other works, this book retains its old merits of clearness, directness and simplicity in its explanations of elementary principles and in its theories, but being written by a resident of England, where there is practically no polyphase work, it gives considerable evidence of lack of touch with the problems and latest practice of Continental Europe and America. Unfortunately for the American readers, the work shows much less appreciation of American than of Continental European practice.

While, as noted above, the work is undoubtedly excellent as a textbook of theory and elementary principles, and therefore to be recommended to all interested in the subject of which it treats, many practical problems met with in modern polyphase engineering, such as

most suitable voltages, the elimination of reactive drops, safety from static discharges, means of preventing hunting, the costs and losses of alternative systems, etc., are not touched upon. Information on practical points desired by the operators of polyphase plants, such, for example, as the best means of starting synchronous motors, the safety devices necessary for compound-wound rotary converters in parallel with storage batteries, or for inverted rotary converters, and the best arrangements of switchboard and switchboard connections, are equally lacking. The new edition contains little of the developments of the last few years, the greater part of its descriptive matter applying to machines, systems and installations of the period from 1890 to 1896, thus making many of its descriptions rather ancient history in the most rapidly progressing branch of electrical engineering. It is unfortunate that there is not a Prof. Thompson in this country and engaged in practical polyphase work to prepare a much needed book on this subject, such as only one uniting the high expository powers of the author of this work and engaged in polyphase engineering, could prepare.

THE BIRD-STONE CEREMONIAL, Being an Account of Some Singular Pre-Historic Artifacts found in the United States and Canada. By Warren King Moorehead. Saranac Lake, N. Y.: Warren King Moorehead. 32 pages, 53 illustrations.

This interesting work relates to the pre-historic ornaments and charms of the stone age known as "bird-stone ceremonials." The 53 illustrations show 100 or more "bird-stones," many of which are of fine workmanship and considerable beauty. To those interested in archæology, this monograph offers much of interest.

BOOKS RECEIVED.

A TRAVERS L'ELECTRICITE. Par Georges Dary. Paris: Librairie Nony & Cie. 429 pages, 8¼ ins. by 12½ ins., 345 illustrations.

TRANSACTIONS OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. Report of Proceedings of the Third Annual Convention, June 20-21, 1899. San Francisco: Offices of the Association. 115 pages, illustrated.

Directory of Electrical Societies, Etc.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next Meeting, Waupaca, Wis., June 26, 27 and 28, 1900.

CHICAGO ELECTRICAL ASSOCIATION. Next meeting, April 6. Paper, "Transformer Design," by Prof. Irwin J. Macomber.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting, Ottawa, Ont., June 27, 28 and 29, 1900.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, Kansas City, Mo., Oct. 16, 17, 18 and 19, 1900.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, Chicago, May 22, 23 and 24, 1900.

NATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Pittsburg, Pa., Sept. 25, 26 and 27, 1900.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Next meeting, New York, Sept. 25, 26 and 27, 1900.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Next meeting, Detroit, Mich., June 20, 1900.

SOUTHWESTERN GAS, ELECTRIC & STREET RAILWAY ASSSOCIATION. Next meeting, Waco, Texas, April 12, 13 and 14, 1900.

Charging and Storage Station for Electric and Other Automobiles.

THE rapid increase in the number of automobiles, more especially electric automobiles, now being used in New York City, both for pleasure and for commercial purposes, has recently brought into prominence the necessity which exists for providing proper and adequate charging and storage facilities for these vehicles at convenient points through Manhattan and the adjacent boroughs of Greater New York. To those who have closely followed the electric automobile development during the past year in New York City, the growing demand for such service has been very apparent and the announcement that steps have already been taken to provide the desired facilities will doubtless prove a source of great satisfaction to the owners of vehicles run on this system and to prospective purchasers as well as to the manufacturers.

That the establishment of a large number of charging stations at different points will be one of the quickest and best ways to foster the growth of the electric automobile industry seems self-evident. The knowledge that such facilities exist will remove one of the few objections that can be raised against the use of the electric automobile, while the greater satisfaction experienced by the owners and users of these vehicles, due to their increased radius of action, will do much toward enhancing the already strongly established popularity of automobilism.

FIG. 1.—ENTRANCE TO STATION.

The accompanying illustrations give two views of a recently organized automobile charging and storage station in a central portion of the city. Fig. 1 is a view of the entrance to this new station, which is known as the Manhattan Automobile Station, and is located at 211, 213, 215 West Thirty-second Street. It is situated but a few doors west of Seventh Avenue, and may be conveniently reached from both Fifth and Eighth Avenues over asphalt pavement.

The building is a five-story one of fire-proof construction. Each floor is asphalted and contains some 5000 square feet of available space. Communication is had with the upper floors by means of a spacious freight elevator capable of lifting the heaviest automobile yet built. Fig. 2 shows a corner of one of the upper floors, and gives an idea of the roomy and airy quarters provided for the vehicles of patrons.

FIG. 2.—CORNER OF ONE OF UPPER FLOORS.

The charging current is obtained from the Edison three-wire mains. Three heavy conductors are led from the junction box in the street along the ceiling of the ground floor to a point well back in the building. These conductors have been put in with an eye to the great growth which the industry seems sure to have in the next few years, and are of sufficient cross-section to carry current enough

for the simultaneous charging of over forty vehicles. These main conductors are tapped at convenient points by branch wires of smaller capacity, which are carried to the several parts of the floor at which vehicles are to be charged. The charging sets are fastened to the walls of the room, and each set consists of a rheostat, a Thomson recording watt-hour meter and a flexible connector with a suitable charging plug attached. By means of the meter a record is obtained of the amount of current taken by each vehicle while on charge. This is carefully noted and filed away.

A competent corps of assistants is on duty to take care of transient vehicles as well as those of regular customers, and adequate facilities for repairing disarranged gears or other parts are always at hand.

Automobiles left in storage are regularly overhauled and tested every day. The voltage of the batteries is noted and a record of the readings is kept, thus preventing a loss of efficiency in the batteries, due to an insufficient charge, while the vehicles are not in use. The other branches, such as washing, oiling, etc., are provided for with the same regard to completeness and efficiency as characterizes the rest of the station equipment.

Mr. Herbert F. Blake, to whose enterprise and foresight the equipping of the station is due, says that he is already much pleased by the favor with which his venture has been received. It is to be hoped that in the near future many more charging stations such as the one just noticed will be established, and that soon many charging hydrants—of the penny-in-the-slot variety—will be found in outlying districts for the use of those wishing to make a more extended tour into the country adjacent to the city than any charging stations in the city would permit.

The Perret Automobile and Battery.

In 1896 Mr. A. Frank Perret built an automobile to carry five persons, using as a source of motive power the electric storage battery. This vehicle was completed and was operated in a most satisfactory manner, but, in common with nearly all other automobiles of similar carrying capacity and mileage, required a great weight of battery, about 1200 pounds. This, of course, necessitated the use of very substantial materials in the construction of the vehicle itself, making the total weight quite considerable. This disadvantage, coupled with the various troubles arising from the best batteries he could obtain and their limitations of output and current, led him to the construction of a type of storage battery which should in itself combine lightness in weight, high rate of charge and discharge, long life and freedom from buckling. Briefly, this is a lead and sulphuric acid type of cell, with Planté element, and in its manufacture nothing is used to cause chemical or electrical troubles in the course of its natural life. Its capacity is stated to be over 14 watt hours per pound of complete cell (including acid), at a discharge rate of 1 ampere per pound. This discharge rate may be greatly exceeded without in any way injuring the cell, but, as is the case with all batteries, it is not advisable to prolong high discharges. The charging may be accomplished much more rapidly than is usually the case.

To make a practical road test of the battery in order to ascertain its real merits as a source of motive power for automobiles, the Perret Storage Battery Co., 21 State Street, New York, decided to build a light vehicle in which should also be included some of Mr. Perret's inventions in these vehicles, which is shown in the accompanying illustration. The vehicle complete, with battery, weighs about 440 pounds, but this weight could be reduced in a future similar carriage. It is well and substantially built, and, while it is only a one-man vehicle, it will carry with ease a person weighing 250 pounds. The truck is made of steel in the form of two triangles connected in the centre by a horizontal king-bolt, to give absolute flexibility to the truck. The reaches terminate at the hubs of the wheels, thereby transmitting all strains in proper directions and eliminating the possibility of breaking of the axles in consequence of any collision. The wheels are 28 inches in diameter and have ball bearings.

This automobile is unique in being operated by a worm gear, which renders it absolutely noiseless. This gear is of a special design, giving a high efficiency. The motor is suspended on the rear triangle of the truck and is directly coupled to the worm shaft.

Another special feature of this vehicle is the controller, which is so arranged that speed changes are effected by means of a divided motor field. Several advantages arise from this method of control, among them being the easily obtained variation of speed, the compactness and positive action of the controller itself, the ability to always discharge all of the cells of the battery in series. No multiple series grouping is necessary, and the cells can also be charged in series, without the necessity of making any complicated connections, before throwing on the charging circuit. The controller itself is very compact, being only about six inches in diameter and three inches in depth. It is operated in the usual way by a lever which is connected to the controller by a crank carrying an appliance for reversing the polarity of the current. By means of this arrangement the same set of contacts on the controller are put in use, whether the vehicle is running forward or backward, thus ensuring great simplicity of operation and a minimum of contact points. The steering is accomplished in the usual manner by pivoted hubs operated by crank levers connected to the steering handle.

PERRET ELECTRIC VEHICLE.

One hundred and seventy-five pounds of battery is used to operate this automobile, and on one charge this will run it about 40 miles over moderately good roads, at an average speed of 13 miles an hour. This little vehicle, of course, is simply intended to demonstrate Mr. Perret's inventions in the line of the storage battery and the improvements in the automobile itself. It is not expected that this vehicle will itself be a type that will come into extensive use, though there are many who will desire automobiles of this kind for special purposes. What has been demonstrated in this vehicle is the ability to build others of greater carrying capacity that will be very much less in total weight than many now on the market, and embodying strength, flexibility and simplicity of operation.

Electric Towage.

Interesting trials of electric traction for the towage of canal boats have recently been made on the Finow Canal, Germany. A small motor carriage of 15-hp and weighing two tons runs on the bank and tows in the same manner as when animal power is used, the speed being three miles per hour.

Portable Electric Light.

The accompanying illustration shows a very convenient form of portable electric light which is only ⅞-in. in diameter and 8 inches long, weighs but 5½ ozs. and can be carried in the vest pocket. The cylindrical shell is made of aluminum and handsomely covered with leather. When not in use the lamp end is covered by a protecting cap; the end of this cap is open, so that when in place the light of the lamp may by this means be concentrated into a pencil of rays. It is stated that the battery, though small, possesses remarkable recuperative powers. When exhausted an allowance is made for the old battery cartridge when exchanged for a new one. All parts of the lamp is made by automatic machinery, which assures a standard product. The manufacturers of the lamp, which is known as the "Light of Asia Lamp," are the Electric Contract Company, 61 Elm Street, New York.

The Murphy Safety Third-Rail System Defied Snow and Ice at Manhattan Beach.

On March 17 the power station at Manhattan Beach was started up and a test made of the Murphy third-rail sectional system in the presence of a number of gentlemen who braved the inclemency of the weather for the purpose. The tracks were completely covered with snow to a depth varying from six to eighteen inches, which was covered with a crust of ice of sufficient strength to bear the weight of a man. The snow had rested upon the rails for a period

PORTABLE ELECTRIC LIGHT.

of three days. The car was started without plough or brushes, either ahead of the tread wheels or the trolley shoe. When the car ran into a snow-bank the wheels would skid upon the rails, necessitating backing up for a distance of about fifty feet, and running into the snow-bank, cutting its way through.

The trip was made successfully through the entire system without any delay, demonstrating that a second car following the first could have gone the entire route without a single stop, as this car was run back and forth a number of times without a single hitch of any character. The ice bonding the power rails to the tread rails did not affect the operation of the switch in the slightest degree, showing that the ice, snow and slush would in no manner prevent the successful practical operation of the system. The switches were tested to see how many breaks per minute were possible, and the track switch, with a 550-volt circuit, made and broke 550 volts successfully 400 times per minute. The heavy switches made for trunk line work were also tested and made and broke 147 times per minute. The road had not been run since September 15, 1899, and the switches were replaced without adjustment to power, or the car not overhauling, which was completely covered with ice and icicles from the hood to the trucks. No previous arrangements whatever had been made to provide for such a severe test.

On March 22 another test of the road was made in the presence of representatives of a number of New York City officials, railway men and electrical and mechanical experts. The system was successfully operated back and forth with the rails completely covered with rust, and numerous successful tests were made, though the system, which had been operated continuously from the 15th day of June to the 15th day of September of last year, the car making 150 trips per day and a total mileage in excess of 12,000 miles, has had no repairs of any character to date.

A Modern Isolated Lighting Plant.

IN the lighting of villas and private residences the necessity for light and power in large quantities for ordinary occasions and for purposes of display and decoration has caused the modern residence isolated plant to become in size and in economy, convenience, reliability and certainty of operation, quite the equal of a small central station. "Lindenhurst," the residence of the Hon. John Wanamaker, on the old Yorktown road, Chelton Hills, Pa., is supplied with light and power from a plant in which the best class of apparatus, installed in conformity with the most modern engineering practice, has been used to meet the requirements.

The boilers, pumps, engines and generators, storage battery and switchboard are located in a quaint and interesting old stone building, formerly a grist mill. The boiler plant consists of two modern 125-hp boilers, built by Samuel Smith & Sons, of Paterson, N. J., and tested to carry 150 pounds steam pressure. The generating plant consists of four General Electric generators, two being of 40-kw capacity, direct-connected to Payne engines, one of 25-kw direct-connected to an "Ideal" engine, and one of a 7½-kw, driven by a motor. A Knowles deep-well pump and a Blake pump are used to supply the tanks and artificial lakes. Electrical tell-tales keep the station informed of the quantity of water in the tanks at all times. The piping for live and exhaust steam, water and drips is laid out in the best manner, all live steam pipes being covered to prevent losses through radiation.

CELL OF STORAGE BATTERY.

The switchboard is conveniently located and designed with particular attention to convenience of operation, and consists of white marble panels, on which are mounted the necessary recording, measuring and controlling instruments. Current is supplied from this switchboard for from 1800 to 2000 lights and an organ motor.

The system is laid out to work on the two-wire 115-volt system for light loads up to 40-kw, and on the three-wire 330-volt system for larger loads. Any dynamo can be connected on either side of the system, thus enabling the generator capacity to be adjusted to the load requirements; for a finer regulation, storage batteries forming part of the plant can be charged or discharged from either side. By this arrangement a great saving in wire was effected.

Pressure wires are run back from the main distributing centers, thus keeping the station informed at all times of the pressure on the terminals of the mains. A main consisting of three 500,000 circular-mil cables supplies the main house, which is located about 900 feet from the generating station.

A three wire No. 3-0 main supplies the swimming baths, dairy, path and road lights, barn, servants' cottages and out-buildings and the superintendent's house. All wire used in the installation is of white core insulation, all wires except the aerial being run in loricated conduits.

To supply light and power when the generating plant is shut down, and to relieve the generators at times of heavy load, a storage battery plant has been installed. This consists of 65 cells, of Gould storage battery, type "S," with a capacity of 500 ampere-hours, the voltage at the end of the discharge being 117 volts.

Each element consists of seven plates, each plate being 15½x15½ inches. The tanks are made large enough to hold four additional plates, and are insulated from the floor and supported by triple-petticoat porcelain insulators. Each tank is so constructed that the lugs of the plates pass through slots and connect with the plates in the adjoining cell, to which they are solidly burned. A rabbet is formed around the top of the tank and fitted with a glass cover. By thoroughly covering the cell in this way the waste of liquid and the unpleasant and injuriously corroding effects of the acid spray are prevented, while at the same time it is possible to examine the elements in each cell without removing the glass covers. The individual plates of the battery are treated by the Gould Storage Battery Company's process of surface formation, whereby the active material is electro-chemically formed from the plate itself as a thin, strongly adherent coating. In the manufacture of the plates great surface is obtained by a number of ribs, and the efficiency is thus brought to a high standard. In charging, the main battery and the end cells are charged at the same time or separately, and while being charged the amount of current can be varied by manipulating the end-cell switch.

The work was installed under the supervision of Mr. Edward Lee Young, the architect, and Mr. Charles N. Hart, engineer, both of New York City.

Electrically Operated Bridge.

The Toledo Bridge Company has recently completed a bridge at Middletown, O., which is operated by a Westinghouse type "C" induction motor. The bridge is 66 feet in width, with a length of 34 feet, spanning a canal in the town, and is just long enough to reach over the canal and the adjoining towpath. To allow barges to pass underneath, the whole bridge has to be raised 8 feet 10 inches, which gives a clearance of 10 feet above the water for boats. The bridge is suspended by wire cables from the tops of four ornamental towers, and is balanced by counter-weights attached to one end of each cable running over pulleys.

The weight of the movable portion of the bridge is about 46 tons, and each of the counter-weights about 23 tons. If there were no friction in the moving parts, such as sheaves rope, shifting gears, wheels, pinions, etc., and the bridge were perfectly balanced by the counter-weights, it could be moved by hand; but to overcome the friction and the inertia, a small motor has been direct coupled to a shaft which operates pinions, current for the motor being obtained from a local electric company. The motor is placed at the center of the bridge beneath the floor, and on the inner face of each post is a rack into which meshes a pinion, these pinions being operated by the motor. Three and eleven-fourteenth revolutions of the rack pinions raise the bridge to a sufficient height. The ratio between the speed of the rack pinions' shaft and the armature of the motor is 1 to 355, the 3 11-14 revolutions of the pinion shaft corresponding to 1344 revolutions of the armature. As the armature speed is 1110 revolutions per minute, about 1¼ minutes are required for the motor to raise or lower the bridge. The time of operation has been frequently checked and found to agree with this estimate.

The motor, which is of the standard Westinghouse "C" type, is direct-coupled to the shaft with no intervening friction clutches, and has therefore to start under a full load, which it does very readily. There have been no readings of current consumed by the motor, but a test was made for torque by the use of a spring scale attached to the armature shaft at a radius of 12 feet. This was found to agree with that shown upon the blue print giving torque and temperature curve, furnished by the Westinghouse engineers. The reason for making this test arose from an attempt to raise the bridge in 30 seconds, which required the ratio between the speed of the pinion and the armature shaft of 1 to 150. The motor refused to do this, and it was thought that it might be deficient in torque. Eventually it was found that the motor fulfilled all the contract conditions and that the trouble was with the bridge, as the amount of friction was greater than had been calculated. The shafting upon the bridge was relined and other changes were made to reduce the friction to the point where the motor could operate freely. A pair of bevel gears with a ratio of 1 to 2½ were introduced, which changed the ratio of pinion and armature shafts from 1 to 150, to 1 to 355. Since then the bridge has run very easily, giving no trouble.

The builders write that in constructing another bridge of this type they are satisfied that by a slight modification of the general design of the operating machinery, the friction could be very much reduced. However that may be, the purchasers of the bridge at Middletown are perfectly satisfied with its rapid and satisfactory operation. The Westinghouse type "C" motor is particularly adapted for this class of work, as it is virtually automatic, having no moving contacts to wear out except the shaft of the armature. It is operated with a minimum of attention, and can always be depended upon to do its duty.

New Type of Rheostat.

The accompanying cut illustrates a new form of rheostat, being placed on the market by Charles Wirt & Co., 1027 Filbert street, Philadelphia. The manufacturers considered in its design the usual defects entering into the construction of such appliances, and believe that in the one shown these faults have been eliminated.

A number of points of superiority are claimed for the rheostat. Mica insulation is used throughout, which insulation is the only kind capable of indefinitely withstanding dampness and sudden excessive temperature changes. There are no small parts, such as nuts, pins, washers and short connecting wires at contact points, to eventually loosen and break down the rheostat. The resistance

NEW FORM OF RHEOSTAT.

is completely encased in iron, thus affording ample protection against injury and offering the utmost active radiating surface. The commutator and switch are constructed to be mechanically perfect, and are thoroughly protected against injury.

The resistance material is a continuous ribbon-wound without break or joint into the desired number of steps, which is never less than fifty. These fifty or more steps make direct contact with the commutator bars, no connecting wires or twisted or soldered joints being used. The resistance is tapered according to the ampere capacity desired at each point, and the steps are graded in proportion to the heat radiating capacity required. This also provides a large switch contact where the current is small.

The resistance ribbon lies flat against the radiating plates, the only substance intervening being a thin sheet of insulating mica. This construction permits the heat to be most readily conducted to the external surface and thence dissipated. The consequence is that the resistance material always runs comparatively cool, a condition which best fortifies it against injury in case of accidental overload. By the method of distributing the heat by means of tapering the resistance and grading the steps, each plate is worked at its greatest efficiency, and therefore a rheostat is enabled to carry a heavier load for the size of plate than is possible under any other conditions.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—There was a general advance in prices during the week, in many cases being quite pronounced. The first upward impetus imparted to the market seems to have been through the announcement on Tuesday that the Metropolitan Street Railway Company had acquired control of the Third Avenue Railroad with all its encumbrances. The misfortunes of this company exercised a depressing influence up to Monday, but a feeling of relief was evident when it became known that its affairs had passed into hands capable of financing it and of managing it upon a profitable basis. A large short interest in Third Avenue was severely punished by the accumulation of stock for control. Conditions in the market for outside securities underwent important changes during the past week—changes very much for the better. Nearly every department supplied one or more issues that showed particular strength, and in some groups nearly every stock advanced substantially. Not since last December had the market been as active as it was last week, and the strength which it displayed was more characteristic of the market of last spring than of any period since that time. Electric Vehicle, the market for which was much improved by the declaration of the 2 per cent. dividend on the preferred stock, showed the largest advances for the week, and all its subsidiary companies were prominent by reason of the large advances recorded. Before dividend action was taken by the directors on Tuesday last there was practically no demand for Electric Vehicle, and the best bid for the common stock was something under 30. On Saturday this issue sold up to 40 and closed at 38 bid, while the preferred stock advanced 26 points for the week, to 86 bid. New York Transportation sold up to 11½ and closed at 11 bid, and proportionally as large advances were recorded in the other transportation stocks. Dun's review says the release of millions employed in preparation for action under the new monetary measure has caused in bank returns considerable changes which are nominal rather than real, and the money markets are undisturbed. The extraordinary exports in three weeks from New York alone, $43,916,895, exceeding last year's by $17,098,814, or 63.8 per cent., have rendered the exchange market weaker, in spite of an increase of $996,000, or 2.7 per cent., in imports at New York for three weeks. Failures for three weeks of March have been $8,444,447, against $4,916,226 last year, $4,906,425 in 1898, and $4,997,301 in 1897. Manufacturing were $3,983,072, against $2,408,421, and trading were $3,524,656, against $2,202,672 last year. Failures for the week were 183 in the United States against 200 last year, and 27 in Canada, against 24 last year. The sales of Brooklyn Rapid Transit during the week were 310,741 shares, the closing quotation being 67¾, a net gain of ⅞. General Electric was exceptionally strong and closed at 131, a net gain of 5 points on the week's transactions; the shares sold were 10,699. Metropolitan Street Railway closed at 162, a net gain of 1 point. This stock, of which 37,429 shares changed hands during the week, was affected by the rumor that the Metropolitan Company would ask to have $25,000,000 additional stock listed. The report was denied by the company; in the meantime the stock yielded 2 points from 162, but it quickly rallied. The highest price for the week was 171½ and the lowest 155. Western Union Telegraph fluctuated between 83 and 84¼, closing at 84, a net advance of 1¼ for the week. The sales of Third Avenue aggregated 293,568 shares, the price ranging between 66½ and 112; the closing quotation was 103½, a net gain of 35¼. In the miscellaneous list Electric Vehicle, common, closed at 35 bid, 45 asked; do. preferred, 80-100; Electric Boat, 22-24; do. preferred, 30-40; General Carriage, 9¼-9¾; Illinois Electric Vehicle Transportation, 2-2½; New York Electric Vehicle Transportation, 10¾; Telegraph, Telephone & Cable of America, 4⅞. The closing prices in Boston were: American Bell Telephone, 315; General Electric, preferred, 138; Mexican Telegraph, 2⅞; Westinghouse, common, 44 bid; do. preferred, 61⅛ bid; Erie Telephone, 105 bid, and West End Street Railway, 93. In Philadelphia the closing quotations of local and other shares were as follows: Electric Storage Battery, common, 81; do. preferred, 86; Electric Company of America, 12½; General Electric Automobile, 2, and Union Traction, 38⅜.

DIVIDENDS.—The following dividends have been declared during the past week: Metropolitan Street Railway Company, New York, 1¾ per cent. (quarterly dividend), payable April 16; the American Bell Telephone Company, 3 per cent. (quarterly dividend), payable April 16; the Electric Vehicle Company, 2 per cent. (quarterly dividend), on its preferred stock, payable April 15; the Boston Electric Light Company, $2 per share (quarterly dividend), payable April 14; the Union Traction & Electric Company of New Jersey, 1 per cent., payable April 2; the E. W. Bliss Company, Brooklyn, N. Y., 2½ per cent. on common stock and 2 per cent. on preferred stock (quarterly), payable April 2; Union Traction Company, Chicago, 1¼ per cent. on preferred stock (quarterly), payable April 20; the Cincinnati Edison Company, 1¼ per cent. (quarterly), payable April 2; Erie Telephone & Telegraph Company, 1¼ per cent., payable April 9; Michigan Telephone Company, 1¼ per cent., payable April 9; Wisconsin Telephone Company, 1¾ per cent., payable April 9.

ELECTRIC STORAGE BATTERY.—The old board of directors of the Electric Storage Battery Company was re-elected last week at the annual meeting held in Philadelphia. The financial statement, which was read by President George H. Day, shows the following results: Gross, 1899, $2,122,679; 1898, $1,163.584; manufacturing purchases, etc., 1899, $1,186,813; 1898, $083,151; gross profits, 1899, $935,866; 1898, $480,433; fixed charges, cost bus., etc., 1899, $326,781; 1898, $220,282; net profits over all expenses, 1899, $609,185; 1898, 260,150; cash for outside securities, 1899, $315,438; 1898, $39,519; net income, 1899, $924,523; 1898, $299,670. The orders received by the company for the past five years were: 1899, $1,500,000; 1898, $1,340,000; 1897, $1,026,925; 1896, $672,281; 1895, $227,433.

THE ST. LOUIS RAILWAY CONSOLIDATION.—Brown Bros. have asked for an extension of one year from April 1 of their option upon the consolidated street railways of St. Louis. The matter is the subject of negotiations between the firm and the St. Louis underwriters of the railway securities. One proposition is the sale by Brown Bros. of $25,000,000 common stock in the east and a cash dividend of 15 per cent. on the bonds.

UNION TRACTION COMPANY, PITTSBURG.—A despatch from Pittsburg states that the terms for leasing the Pittsburg Consolidated Traction by the new Union Traction Company are a guaranteed dividend rental basis of 6 per cent. on the preferred to April 1, 1906, and 7 per cent. thereafter, and a sliding scale on the common running 2 per cent. for two years, 3 per cent. for three years, 3½ per cent. for two years and 4 per cent. thereafter.

ILLINOIS ELECTRIC VEHICLE.—A special meeting of the stockholders of the Illinois Electric Vehicle Transportation Company has been called for April 5, to be held in Jersey City. At that meeting the shareholders will be asked to vote on the proposition to reduce the capital stock from $25,000,000 to $2,500,000, the shares being reduced from $100 to $10 each, on which $5 has been paid.

TELEGRAPH AND TELEPHONE STOCK LISTED.—Stock of the Telephone, Telegraph & Cable Company of America, to the amount of $13,765,000, it is reported, has been admitted to the unlisted department of the Philadelphia Stock Exchange.

LISTING MORE ERIE TELEPHONE STOCK.—Application has been made to list 50,000 additional shares of Erie Telegraph & Telephone stock on the Boston Stock Exchange, making $10,000,000 listed out of an authorized capital of $15,000,000.

Commercial Intelligence.

THE WEEK IN TRADE.—Some few irregularities are visible in the general trade and industrial situation, the results of the workings of counter currents in various lines, but, taken as a whole, says Bradstreet's review, the general outlook retains most of the encouraging features noted for some time past. Continued good railroad earnings returns, record-breaking merchandise exports from New York, with signs of a resumption of heavy shipments of iron to Europe, and good wheat and fruit crop reports, exports from the central west, are also features. An unfavorable element is the prediction of a general strike of machinists, but it is possible that more than its proper weight has been given this threatened trouble. Copper has maintained a steady advance, no quotations for spot Lake being obtainable at the close of the week at less than 16½c. Official quotations given by the New York Metal Exchange are 16½c for spot Lake, an advance of ⅛c per pound over their figures of a week ago. The closest quotation obtainable on electrolytic cakes, wire bars and ingots is 16⅜c, and this figure also holds good for casting stock. Amalgamated copper closed strong at 97; British Columbia copper was ¾ lower at 9¾. A Philadelphia despatch states that engineering plants, bridge, car and locomotive works,

as well as foundry and machine shops, still continue to book encouraging orders from urgent buyers for the earliest possible delivery. The situation there in iron and steel is about the same as the week previous as to prices. All the large steel combinations, it is further stated, are in a position to maintain prices, and intend to do so, even though a policy of restriction should become necessary later in the season. Orders for 17,000 tons of structural material were booked last week.

OPPORTUNITIES IN SPAIN.—We are in receipt of some interesting data on electrical opportunities in Spain, from Mr. Eduardo Mestre, assistant manager of the Bureau of Expert Translations, 101 Pearl Street, New York City. He says: "Reports from our friends in Madrid (Spain) and almost every city in that country show that in industrial undertakings this will be a banner year in Spain. The establishment of central electric lighting stations in many interior towns seems to be a particular feature, to which the attention of American engineering firms is called, as London and Berlin firms are turning their attention towards Spain as a promising field. The water power of the River Turia is to be utilized at an early date, establishing an electric lighting station at Villa Marchante. In Piedrahita (Avila Province) a fifteen-year concession for the electric lighting of the town is to be shortly given. In these undertakings both English and German concerns are figuring extensively, and through the latter considerable American-made material has been furnished. Not only in electrical undertakings, but in other branches as well, is Spain making headway fast. Coal and iron mines are being worked to a greater extent this year, and railroad projects are not lacking. Every week there are more or less shipments directly from New York to Barcelona, but they could be increased to ten times their amount in less than six months in the opinion of merchants in a position to know. The co-operation of manufacturers is required, however, in order to carry out successfully the exportation of a vast variety of manufactured goods which would find a market in our extensive field. To Gijon there have been some substantial shipments from this city lately, such as machinery, tools, windmills, and electrical material. Spanish catalogues are greatly needed, and I say good, as the ones we have here are miserable in language, and we doubt that all the goods represented are of American manufacture, as they come through English or German houses."

AN INTERNATIONAL TRADE COMPLICATION.—A commercial case of much importance to the export trade has recently been the subject of diplomatic correspondence between the State Departments of this country and Nicaragua. About five years ago a Cincinnati manufacturing company contracted to deliver material to be used in the construction of an electric light plant in Bluefields. The amount was not large—about $1700—and after calling on the Nicaraguan consul a draft offered in payment and drawn on a New Orleans bank was accepted. The draft was not paid at maturity and during the interval the goods had left the country. The company then sent an agent to Bluefields with instructions to bring the material back. The agent found the man who made the purchase in possession, but the work not yet being started. The agent secured the goods and started to ship them, when the Intendente Governor Reyes intervened with an embargo. The agent managed to take away a few small but expensive pieces in his trunk, but about $1500 worth of the material remained. The matter drifted along until the Cincinnati firm, finding it could get no satisfaction from the Nicaraguan government, took it up with the authorities at Washington. As a result, Secretary Hay and Minister Corea signed a protocol in Washington last week leaving the matter to arbitration. General E. P. Alexander, of Savannah, Ga., who served during the Cleveland administration in settling the boundary dispute between Nicaragua and Costa Rica, was named as the expert to decide the matter.

EXPORTS OF ELECTRICAL MATERIAL.—The following were the exports of electrical material and kindred lines from the port of New York for the week ended March 24, 1900: Antwerp—113 cases electrical material, $13,053. Argentine Republic—307 cases electrical material, $27,945. Aberdeen—6 cases electrical material, $2225. Amsterdam—1 case electrical material, $17. Berlin—14 cases electrical material, $32. Brussels—5 cases electrical material, $86. Bucharest—7 cases electrical material, $75. Brazil—27 cases electrical material, $1529. British West Indies—19 cases electrical material, $291. British Australia—267 cases electrical material, $13,366. Central America—54 cases electrical material, $939. Cuba—109 cases electrical material, $1330. Ecuador—15 cases electrical material, $350. Gottenburg—8 cases electrical machinery, $1717. Glasgow—15 cases electrical material, $3825. Hull—4 cases electrical material, $2000. Hamburg—44 cases electrical machinery, $1525. Havre—330 cases electrical material, $23,646; 46 cases electrical machinery, $1875. Japan—1 case electrical material, $200. London—19 cases electrical machinery, $3079; 157 cases electrical material, $5998. Mexico—159 cases electrical material, $7878. Manchester—7 cases electrical material, $121. Malaga—2 cases electrical material, $68. Rome—14 cases electrical material, $121. Southampton—11 cases electrical machinery, $2620. Vienna—2 cases electrical material, $40.

FOREIGN COMMERCE DURING FEBRUARY.—The month of February, 1900, has made the most remarkable record of any February in the history of our foreign commerce. The exports during that month have averaged $5,000,000 for every business day in the month, and the total exports were $119,765,762, or more than 25 per cent. greater than that of any preceding February. Not only are the exports larger than those of any preceding February, but the excess of exports over imports is also much larger than in any preceding February, surpassing those of 1898 by nearly 25 per cent., and being more than 50 per cent. in excess of that of any earlier year. The relative importance of the February, 1900, record will be more clearly seen when it is stated that the average February exports during the last ten years were $76,000,000 per month, while the total exports of February, 1900, as already stated, were $119,765,762. This makes the total exportation for the eight months ending with February about $75,000,000 greater than that of the corresponding months of the fiscal year 1899, and makes it apparent that our total exports in the fiscal year ending June 30 will exceed those of any preceding year by probably $100,000,000, and carry the total commerce of the year considerably beyond the $2,000,000,000 line.

CINCINNATI WANTS A NEW INDUSTRY.—A Cincinnati correspondent says: There has developed a need in Cincinnati of a firm which will devote its time and energies to the installation of electric elevators. A group of prominent manufacturers and men of business were discussing elevators the other day, and it was discovered that there are comparatively few electric elevators in Cincinnati, and that there is a very good demand for the same. There are a number of big concerns that furnish motors and equipment, but none of them have a department devoted to the professional installation of the improved lifting machines.

THE CROCKER-WHEELER COMPANY, New York, is now installing for the Cudahy Packing Company's new plant at Kansas City, Kan., the following apparatus for power transmission and lighting; One 350-kw generator, speed 130 r. p. m., direct-connected; one 200-kw generator, speed 175 r. p. m., direct-connected; and the following motors: One 75-hp, five 50-hp, five 35-hp, three 25-hp, two 20-hp, seven 15-hp, three 10-hp, two 7½-hp, three 5-hp, five 3-hp, and a switchboard. The Cudahy Packing Company is also using Crocker-Wheeler apparatus for power transmission and lighting work at its Sioux City plant.

SIEMENS & HALSKE COMPANY.—The following, purporting to be a telegram from New York, appeared last week in a Boston financial journal. "The Siemens-Halske Electrical Company is to go out of business. This will divide the electrical territory pretty thoroughly between the Westinghouse and General Electric Companies, with enormous profits for each. Quiet buying of General Electric has been noticed in the market the past few days." The report, upon investigation, proves to have absolutely no foundation.

THE WASHINGTON ELECTRIC VEHICLE COMPANY commenced operations in Washington, D. C., in February and now occupies its own station, which has a capacity for 150 vehicles; 60 vehicles are now in use, and additions to the number are being made weekly. This plant gives Washington the finest automobile outfit in the world, and as its streets make it a particularly desirable city for automobile operations, it is believed that the electric vehicle will become one of the features of that city.

COAL-HANDLING PLANT FOR EGYPT.—The Brown Hoisting & Conveying Machine Company, of Cleveland, O., is building an immense coal handling plant for the Egyptian State Railway at Alexandria, Egypt, at a cost of over $300,000. The company has also just made an immense shipment of machinery to Australia, as well as filling important orders in China, Brazil and Sweden.

THE BRUSH ELECTRICAL ENGINEERING CO., 49 Queen Victoria Street, London, England, is desirous of securing an experienced manager for their Falcon works at Loughborough. Fifteen hundred men are employed in the works, the manufactures being machinery for electric light, power and street railway work.

A NEW WIRE CORPORATION.—The National Wire Corporation has been organized at New Haven, Conn., to take over the business of the National Wire Company, of that city. Its capital stock is $1,000,000. Boston people interested are Edward W. Cates, of Newton, and Everett B. Webster, of Beverly, Mass.

AMERICAN RAILS FOR LONDON.—The Maryland Steel Company, Baltimore, Md., has received an order for 1500 tons of rails for the London Metropolitan Railway Company. The Maryland Company is supplying rails for the Trans-Siberian Railway and for other parts of Asia and for Africa.

Special Correspondence.

ENGLISH NOTES.

London Office of ELECTRICAL WORLD AND ENGINEER, March 10, 1900.

OVERHEAD WIRES IN THE CITY.—The corporation is taking action with a view to safeguarding the public against the dangers of overhead wires in the city. A notice has been published warning the owners of all wires, supports and attachments to place identifying marks upon them in accordance with the London Overhead Wires act 1891. If the work is not completed on or before Thursday, April 1, they will be removed. The penalty of failing to comply with the demand is £5, with a further penalty not exceeding 40s. for each day the offence is committed after a conviction is recorded. The corporation possesses full powers to deal with overhead wires, and, if the act is not carried out within all reasonable limitations, the offending wires can be cut, and communications destroyed. Such an extreme measure is not likely to be taken by the corporation at the present juncture, but certainly it is high time that the owners of overhead wires should realize their responsibilities.

THE NATIONAL TELEPHONE COMPANY, which in Great Britain occupies a similar position to the American Bell Telephone Company of the United States, desires to increase its capital by £1,000,000, and is now seeking powers in the usual manner to borrow that sum, for which it proposes to issue £500,000 in 4 per cent. debenture stock and a similar amount in ordinary shares. The existing gross capital of the company is £6,000,000, so that when this further sum is raised the total issued capital will amount to the large sum of £7,000,000. The company has been able in the past to pay a 6 per cent. dividend on the ordinary shares, but now that it will encounter the competition of the post office, which has decided to take up the telephone business in Great Britain, it is feared the new issue of stock will not be so readily subscribed. The National Telephone Company has enjoyed for a good many years the monopoly of the telephone business, but it is likely to have severe competition from the post office before long.

200-VOLT LAMPS.—Though the 200-volt lamp has not made much progress in the United States, it is interesting to note that in Great Britain there are now as many 200-volt incandescent lamps in service as 100-volt lamps, and from inquiries from various people interested in the situation, it is gratifying to know that the higher voltage lamp is giving as great satisfaction as the old form of lower voltage lamps. The Board of Trade some time ago gave its consent to the use of higher voltage, and many of the stations which were installed years ago having plant adapted to furnish current at about 100 volts are being remodeled to give current at 200 volts, and the house services have been overhauled, and such changes made as are necessary by the change to a higher voltage. The 200-volt lamps may, therefore, be safely said to have come to stay in England, and as most of the central stations are working on the three-wire system, the general voltage of the dynamos supplied is about 450 to 500 volts, the voltage of the lamps being from 200 to 225 volts.

WATER POWER DEVELOPMENT IN IRELAND.—We have before noted in these columns that not much has been done in Great Britain in the way of water power developments for electrical purposes, for the simple reason that there does not exist to any great extent water powers that can be taken advantage of. It is therefore more interesting to note that a scheme is being promoted, called the Shannon Water & Electric Power Scheme, which has been receiving the careful attention of the Limerick County Council. The River Shannon, in Ireland, is proposed to be taken advantage of, and the waters of Lough Derg will also be utilized in a storage capacity. It is proposed to develop 8000 hp and to supply motive power, if required, in the district, within a radius of from 20 to 35 miles, for manufacturing purposes, and which can be done at less than half the cost of steam. On labor alone the promoters would spend about £200,000, and the necessary plant would involve an expenditure of another £100,000. The County Council resolved to approve the scheme of the Shannon electric power bill, provided all vested rights were properly protected and safeguarded, so that it is possible that we may see within a comparatively short time a good water power electric scheme in Ireland.

NEW ENGLAND NOTES.

Boston, Mass., March 26, 1900.

WINTHROP ELECTRIC RAILWAY.—Opposition developed at a town meeting and reduction in steam road fares dim the prospects of the projected electric road to connect Winthrop with Beachmont and Revere.

BOSTON ELECTRIC RAILWAY SUPPLY TRADE.—The various Boston firms which handle railway material, whether as manufacturers or dealers, report there is no cessation in the demand for goods, and all are more than crowded with orders that are both numerous and good.

THE BOSTON ELEVATED.—The open and mild winter has been a great advantage for enabling work on the elevated railway structure in Boston to continue without intermission. Great progress has been made at Dudley Street. There will be a loop around which all cars on the elevated will run for the return trip through the city into Charlestown. Work on this loop is going along at a capital pace, and ere long the rails will be laid. Nor is much time being lost at the site of the big central power station that is to be built on the site of the old Lincoln wharf on Atlantic Avenue. It would appear as if the time remaining within which the company has to have the entire system completed—by next July twelve-month—will be amply sufficient.

NEW ENGLAND RAILWAY CONSOLIDATIONS.—At the rate the various electric street railway companies throughout Massachusetts are consolidating the time may not be long ere there will be but one huge corporation having in control the entire system of the old Bay state. It is doubtful if in any other state of the union there is such a network of roads as have been built throughout this state, and each one of them is doing a phenomenal amount of business. Taking Boston as a centre or starting point, it is now possible to take an electric car and make a continuous ride up into New Hampshire on the north; while it is equally easy to visit every city in the south part of the state and then proceed with but slight interruptions right on to New York City by electric car. Practically every line or system north of Boston is now under the control of one board of management, while immediately to the south the same thing prevails. It is reported that a movement is about being consummated that will result in a huge combination for controlling all the roads that are being operated in the central part of the state, with Worcester as the centre. In and around or connecting that city with many surrounding towns and cities are most of a dozen different roads, and it has been about decided that it will be of advantage for all to go into a strong combination. The different roads which are to be included in this new deal own and operate about 127 miles of track, over which no less than 20,000,000 passengers were carried last year, and they all lie through districts and towns where the traffic can be largely increased in the immediate future.

General News.

THE TELEPHONE.

ROME, N. Y.—The Common Council has awarded a franchise to the Rome Home Telegraph Company.

CEDAR RAPIDS, IA.—A telephone company has been incorporated at Clarion with $10,000 capital stock.

COLUMBUS, OHIO.—The Citizens' Telephone Company, of Coshocton, has increased its capital from $10,000 to $30,000.

GERMANTOWN, OHIO.—The Germantown Independent Telephone Company has been incorporated with a capital stock of $2500.

DAYTONA, FLA.—Eugene T. Conroy, J. E. Long, Frank T. Peck, George H. Clark and others have organized a telephone company here.

BESSEMER, ALA.—The Bell Telephone Company will take immediate steps to double the trunk facilities between this city and Birmingham.

CLEVELAND, OHIO.—The Cleveland Telephone Company has asked permission to extend its system through the village of Collinwood.

WEST ALEXANDRIA, OHIO.—The West Alexandria Telephone Company, of this place, has been incorporated with a capital stock of $3000.

SWEETWATER, TENN.—The Sweetwater Telephone Company will be in the market for instruments and all construction material except wire.

GREENVILLE, S. C.—Greenville Telephone Company, Greenville, N. C., wants catalogues from manufacturers of telephone equipment and supplies.

BALTIMORE, MD.—A certificate of the reduction of the capital stock of the Maryland Telephone Company from $200,000 to $50,000 has been recorded.

WABASH, IND.—The Bell Telephone Company is reported to be after the Home Company, in this city, which has practically obtained control of the local business.

COLUMBUS, IND.—John Grant and other business associates have organized an independent telephone company, to be known as the Flatrock Telephone Company.

LIMA, OHIO.—The Lima Telephone Company has been granted a franchise to construct conduits and maintain an underground system of telephone wiring in the city.

MENOMINEE, WIS.—The Wisconsin and Michigan Telephone Companies will build six new trunk lines between this city and Marinette, making ten in all to be operated here.

SPRINGFIELD, MASS.—The Hampden Automatic Telephone Company, which was recently granted a franchise in this city, has filed a petition for a franchise in Holyoke.

CHICAGO, ILL.—The Tri-County Telephone Company of Tamaroa has been incorporated. Capital stock, $2500. Incorporators: Guy Blanchard, J. D. Morris and A. J. Fitzgerald.

FORT WORTH, TEX.—The new exchange of the Southwestern Telephone & Telegraph Company was recently formally opened. The event was celebrated by a public reception.

INDIANAPOLIS, IND.—The Ripley County Farmers' Co-operative Telephone Company, of Carthage, has been incorporated to construct and operate a telephone system to accommodate farmers throughout Ripley County.

SPRINGFIELD, MASS.—The Board of Aldermen have granted a franchise to the Hampden Automatic Telephone Company. The action of the Aldermen is the first successful attempt to invade the Bell field in Western Massachusetts.

DUNMORE, W. VA.—The Pocahontas Telephone Company has been incorporated to construct telephone line from Marlinton to Repose. H. M. Moore, Samuel Shidder, B. F. McElrose and others are the incorporators. Capital, $1000.

SHELBYVILLE, IND.—The Bell Telephone Company, which put in telephones here some time ago free of charge, in order to crush the local company, has announced that after April 1 the prices for service will be the same as the local company.

CHATTANOOGA, TENN.—It is stated that the Bell Telephone Company has secured a controlling interest in the East Tennessee Telephone Company, and that the latter is to be merged with the Cumberland Telephone Company into one extensive system.

CHAGRIN FALLS, OHIO.—The Bell Telephone Company was recently refused a franchise in this place. The independent company, owned and operated by local people, has several times reduced rates, and the council declared its intention of protecting the home industry.

ASBURY PARK, N. J.—The Monmouth Telephone Company has been organized, with a capital of $25,000, with the expectation of developing an exchange on the Atlantic coast in New Jersey, with Asbury Park as a centre. H. B. Ayres, 19 Liberty Street, New York, is largely interested.

MANITOWOC, WIS.—The Wisconsin Telephone Company is contemplating making improvements to its plant. The company expects to lay about 10,000 feet of cable along the principal business streets, to take the place of the present overhead wires. A new cable will also be laid across the river.

RAVENNA, OHIO.—The new management of the Ravenna Home Telephone Company is making improvements which will greatly increase the efficiency of the system. An order has been placed for a new metallic switchboard, also a considerable amount of cable. The exchange will commence operations with 200 subscribers.

INDIANAPOLIS, IND.—The New Telephone Company has filed an $800,000 mortgage on its property, franchises, etc., in favor of the Central Trust Company. The instrument cancels the $500,000 mortgage made at the time the company began operations. The additional $300,000 obtained will be used in making improvements.

PHILADELPHIA, PA.—The Ambler Telephone Company has been organized by the election of the following named officers: President, John S. Buchanan; vice-president, L. S. Moore; secretary, William S. Acuff; treasurer, Joseph A. Angeny. William J. Devine has been made superintendent, and will at once commence the erection of the line.

AUSTIN, TEX.—An independent telephone company is in operation in Waco, and another will soon be ready for operation in Houston. A franchise has been granted by San Antonio to H. M. Aubrey and associates for the establishment of an independent exchange. This competition will cause a general reduction in rates. The new companies charge $3 per month for business instruments and $2 for residences.

SANTA BARBARA, CAL.—The Sunset Telephone & Telegraph Company was defendant in a drainage suit recently won by George Russel, in Santa Barbara, Cal. He claimed that while attempting to receive a message over the telephone company's lines last May he received a severe electric shock, as a result of "central's" turning on the "buzzer." He sued for $10,000, but was awarded only $300 by the jury in the superior court.

MILWAUKEE, WIS.—The Wisconsin Telephone Company will erect exchange buildings in various cities in this State during the spring, contracts having already been let for a building at Madison, and one for the construction of a new building at Racine is now under consideration. La Crosse and Eau Claire are also to have new buildings, each to cost $15,000. Mr. H. J. Esser, of this city, has the plans of the two latter buildings nearly completed.

OSHKOSH, WIS.—The Little Wolf Telephone Company is now connected with this city, a toll station having been established here on March 22. The company came into Oshkosh over the line of the Oshkosh Northwestern Company. When the company sold out to the Erie, the latter cut the Wolf River line, and its subscribers have for weeks been without connection with this city. The Little Wolf Company has applied for a franchise to install a local exchange here.

FORT SCOTT, KAN.—The Union and Independent long distance telephone companies, of Kansas and Missouri, with 300 miles of lines in the two states, have just been consolidated under the name of the Kansas Telephone Company, with a capital of $200,000. The company has connections with the other independent long distance companies of Kansas and Missouri, to compete with the Bell company. All these long-distance companies want an independent company to get a franchise in Kansas City, in order to give them connections with St. Louis and Chicago by way of that city.

ATLANTA, GA.—At a meeting of the stockholders of the Marietta Telephone Company, the directors authorized Mr. J. L. Clark, principal stockholder, to sell out the plant and to close the exchange. Mr. Clark has sold the plant, and business will be discontinued on April 1. He stated that the exchange had about 200 stations, all working on metallic circuits, and that the patronage had been liberal, but the mistake of placing their rates too low in the beginning had been made, and it was not possible to run the business, much less make any money, and for that reason it would be discontinued.

AUSTIN, TEX.—The Lone Star Telephone Company, with a capital stock of $500,000, has been incorporated. The company will establish exchanges in Galveston, Houston, Austin, San Antonio, Laredo, El Paso, Fort Worth, Whitesboro, Denison, Paris, Texarkana, Longview and Dallas. The principal office will be in Austin. The incorporators are: J. B. Earle and J. E. Boynton, of Waco; H. M. Aubrey and F. C. Smith, of San Antonio; W. H. Eager, James J. Brailey, of Wauseon, Ohio; J. M. Longnecker, Delta, Ohio; W. H. Harper, Jr., John P. Bailey, Ottawa, Ohio; James King Duffy, New York City; W. A. Armstrong, Doniphan, Ohio.

ELECTRIC LIGHT AND POWER.

PHILADELPHIA, PA.—William J. Adamson is about to organize an electric lighting company at Paulsboro.

XENIA, OHIO.—The Xenia Electric Light Company has increased its capital stock from $10,000 to $50,000.

ATLANTA, GA.—W. C. Rawson, of the Elizabeth Cotton Mills, of this city, desires estimates on an electric light plant.

ATHENS, GA.—It has been definitely decided to build a power plant at Tallassee Shoals, in this county, to cost $100,000.

CARBONDALE, ILL.—The city has under negotiations the purchase of the electric light plant of the Carbondale Electric Light Company.

PARIS, TEX.—The town council of Cooper has granted a franchise to Dallas parties to establish and operate an electric light plant at that place.

SAGINAW, MICH.—A proposition to establish a municipal lighting plant at Saginaw was adopted at a special election. The bond issue will be $75,000.

HOUSTON, TEXAS.—The city will advertise for new plans for an electric light plant to furnish 500 arc lights and 6000 incandescent lights. Address Engineer Potter.

TOMAHAWK, WIS.—The electrical equipment of the new Marinette, Tomahawk & Western Railway Company's elevator at this place has been put in operation. Water power is the prime power.

ALTON, ILL.—The Alton Electric & Service Company is tearing down the old water works building, and rebuilding it for an electric light plant. Some of the machinery for the new plant has arrived.

MARION, IND.—B. F. Burk and W. H. Anderson have begun the construction of an electric light plant in this place for commercial purposes. It will be known as the Marion Electric Light Company.

PERU, IND.—The city council has granted a franchise to Messrs. Ulen and Perrott, of Indianapolis, for an electric light plant or system. At the expiration of 10 years the city will be given a deed to the plant.

MANITOWOC, WIS.—A petition signed by nearly 500 citizens will be presented to the council, opposing the granting of a franchise to a company to erect an electric light plant. A municipal plant is favored.

SAN JOSE, CAL.—The Union Electric Company, San Jose, Cal., has been incorporated with a capital stock of $300,000. The directors are: W. L. Hood, Z. L. Cornwall, F. L. Emerson, E. J. Emerson and F. F. Britton.

CAMDEN, N. J.—The Consolidated Light, Heat & Power Company, of Camden, has been incorporated, to furnish electric light, gas, etc. Capital, $500,000. Incorporators: F. A. Magowan, B. C. Warnick, J. W. Weart, all of Camden.

YARDLEY, PA.—The Yardley Electric Light, Heat & Power Company has been chartered at Harrisburg, with a capital of $25,000. This company will operate the plant here recently purchased of David Peoples, of Philadelphia.

WILLIAMSON, W. VA.—The Williamson Electric Light & Power Company has been incorporated, with an authorized capital of $50,000. Incorporators, C. H. Jones, Thomas B. Garner, John A. Shepherd and Wells Goody Koontz.

MILWAUKEE, WIS.—City Attorney Runge has given an opinion that the Smith plan for a municipal electric lighting plant to be submitted to a vote of the people is legal, but that the decision of the people would simply be advisory to the council and not mandatory.

SAN FRANCISCO, CAL.—The Independent Electric Light & Power Company, San Francisco, has completed the walls of its new main power station. The substation buildings are enclosed, and nearing completion. Conduit work is rapidly progressing in the principal streets of the city.

TRENTON, N. J.—The Cauto River Company, for the operation of electric light, heat, power and gas companies in Cuba, was incorporated with a capital stock of $1,000,000. The incorporators are Edwin M. Post and Percival Farquhar, of New York, and T. L. Dragaw, Jr., of Coytesville, N. J.

ST. PAUL, MINN.—The Manhattan Light, Heat & Power Company intends to enter the field in opposition to the Edison Electric Light & Power Company in the lighting of buildings and portions of the city. The plant now operated by the company has been enlarged, and the company intends to extend its lines outside.

BALTIMORE, MD.—A bill has been introduced in the legislature to incorporate the Consumers' Electric Light & Power Company, of Baltimore City. Capital stock $1,000,000, with privilege of increasing to $5,000,000. Among the incorporators are A. A. Brager, Ernest J. Knabe, Jr., Samuel R. Rosenthal, George J. Record and others.

BELLEVILLE, ILL.—The Belleville Gaslight & Electric Lighting Company submitted to the city council a proposition for a new contract. The company offered to furnish lights for the next ten years under the previous moonlight schedule at $62.50 a lamp a year. The price under the old contract was $75 a lamp. The total would be about $2000.

HAMILTON, ONT.—The Cataract Power Company, of Hamilton, Ont., it is understood, has arranged to supply power to another large factory to be built in this city. It is said that this contract will about exhaust all the surplus power now generated by the Cataract Company, and that arrangements will at once be made to increase the power supply.

REDDING, CAL.—The General Electric Company was awarded the contract for the Mt. Shasta Electric Company's electric transmission to Redding, the Keswick smelters and the Delamar mines. The same company also secured the contracts for the new apparatus to be installed by the Electric Improvement Company, of San Jose, Cal., to replace the plant which was destroyed by fire.

INDIANAPOLIS, IND.—Several companies are seeking a franchise to operate the Yaryan system of heating houses with hot water in this city. The petitions ask for the privilege of furnishing electric light also to their consumers, and the companies are meeting with much opposition from electric light companies, which insist that the city should not grant an electric lighting franchise in conjunction with the hot water franchise.

COLUMBUS, OHIO.—Director Kauffman, of the water works department, Columbus, Ohio, has announced that in his opinion the municipal electric lighting plant, operated in connection with the water works, is one of the expensive features of his department, and should be abandoned. The annual report of the director will show that the cost of operating the municipal plant per lamp more than doubles the cost of the contract lamps at the present time. The city council has ordered an investigation.

COLUMBUS, OHIO.—An ordinance will be introduced in the city council authorizing an appropriation to build and equip an electric lighting plant of sufficient capacity to light the entire city; the same to be constructed at the expiration of the present contracts with private parties, about 18 months hence. There still remains $232,000 of the $300,000 bond issue for a municipal lighting plant authorized by a vote of the people three years ago, and it is the intention to utilize this sum for the proposed plant.

ST. LOUIS, MO.—Bids for lighting the streets and alleys of the city within the conduit district by electricity were opened March 20. The following bids were received: Missouri-Edison Electric Company, $32.90 per 1000 lamp hours,

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arc lights, $5.84 per 1000 lamp hours, incandescent lights; $135.09 cost each lamp per year, arc lights, $23.98 cost each lamp per year incandescent lamps. Laclede Gas Light Company, $30 per 1000 lamp hours arc lights, $6.25 per 1000 lamp hours incandescent lights; $123.18 cost each lamp per year arc lights, $25.66 cost each lamp per year incandescent lamps. D. W. Gurnsey, $29 per 1000 lamp hours arc lights, $6.08 per 1000 lamp hours incandescent lights; $119.07 cost each lamp per year arc lights, $24.96 cost each lamp per year incandescent lamps. Seckner Contracting Company, $23.77 per 1000 lamp hours arc lights, $4.79 per 1000 lamp hours incandescent lights; $97.66 cost each lamp per year arc lights, $19.66 cost each lamp per year incandescent lights. The Seckner Contracting Company, of Chicago, being the lowest, the contract was awarded to it, subject to the action of the city council. The bid of the Chicago company makes the annual cost to the city for lighting $99,640.30.

THE ELECTRIC RAILWAY.

HAVANA, CUBA.—The Havana Electric Railroad opened a few miles of its new road on March 10.

FAYETTEVILLE, N. C.—J. W. McNeill has received a franchise to build an electric railway. A company will be organized.

HAMPTON, VA.—D. H. Geddy, R. L. Spencer and others are interested in the Yorktown, Poquosin & Hampton Railroad Company.

MASSILLON, OHIO.—The city council has granted a franchise to the Barberton, Doylestown & Massillon Electric Railway Company.

CLEVELAND, OHIO.—It is proposed to consolidate the Cleveland & Chagrin Falls and the Cleveland & Eastern Electric Railway companies.

AUGUSTA, GA.—It is reported that the Georgia Railroad Company is considering the operation of its line by electric power between Washington and Barnet, Ga.

CIRCLEVILLE, OHIO.—The Chillicothe, Mt. Sterling & Columbus Electric Railway Company has applied for franchises over two routes through Pickaway County.

ACCOMACK, VA.—The business men of Accomack, Onancock and Tasley, Va., are considering the formation of a company to build an electric railway between these points.

BOSTON, MASS.—A Boston syndicate has purchased stock control of the Worcester & Suburban Street Railway Company. The Worcester & Suburban owns 30 miles of road.

KANSAS CITY, MO.—The surveys are being made for the proposed electric line between Kansas City and Olathe. Messrs. Burns & McDonnell, of Kansas City, are the engineers.

DAVENPORT, IOWA.—The contract for the rebuilding of the Third Street line of the Tri-City Railway Company has been let to the Falk Manufacturing Company, of Milwaukee.

NATCHEZ, MISS.—J. C. Shaffer and H. W. Rogers, of Chicago, and F. S. Mordaunt, of Vicksburg, Miss., it is reported, are interested in the plan to build a street railroad in Natchez.

MARION, IND.—The Tippecanoe Traction Company, composed of Wabash and Warsaw capitalists, was granted a franchise over the Wabash pike from the city limits to the county line.

SHELBYVILLE, IND.—A newly organized local company has asked for a franchise to build and operate a street railroad system in this city. E. A. Adams is president of the company.

NEW ORLEANS, LA.—It is reported that Loren N. Downs, of Philadelphia, Pa., has become interested in the proposed electric railway being promoted by the Orleans & Jefferson Railway Company.

HARRISBURG, PA.—A meeting of the stockholders of the Greensburg & Hempfield Street Railway Company will be held at Greensburg, March 30, for the purpose of reorganizing the corporation.

BIRMINGHAM, ALA.—J. H. Mountain, of Piedmont, who represents Chicago capital, has secured an option on the street railway lines of Selma. He is also seeking an option on the electric light plant.

GALESBURG, ILL.—The Galesburg & Monmouth Rapid Transit Company is about to begin the construction of its line. The company is composed of Galesburg capitalists. The capital stock is $200,000.

WAREHAM, MASS.—The selectmen of Wareham finally signed the franchise for a right to construct in this town an electric railway to the Middleboro, Wareham & Buzzard's Bay Street Railway Company.

LEESBURG, VA.—It is reported that a company has been formed to build an electric railroad from Leesburg to Harper's Ferry, a distance of 17 miles. Paul Evans, of Philadelphia, is one of the promoters.

CHATTANOOGA, TENN.—The Chattanooga Rapid Transit Company has purchased the Signal Mountain Railroad line and, it is understood, will make a number of improvements as well as several extensions.

HARPER'S FERRY, W. VA.—The Harper's Ferry Power Company has been organized for the construction of an electric railway and will build power house, etc. Mr. Powell Evans, of Philadelphia, is interested.

MONTREAL, QUE.—The Montreal Electric Street Railway Company will issue an additional million of stock, the funds to be used for additional machinery and new cars, and to pay for improvements already made.

KALAMAZOO, MICH.—The Kalamazoo Valley Electric Company has formally applied to the Marshall council for an electric railway franchise through that place, the application being made in the name of F. N. Rowley.

BRISTOL, VA.—The Clifton Land Company, recently organized, it is stated, is considering the construction of an electric railway in the suburbs. Among those interested are George L. Carter and A. S. McNeil, of Bristol.

NEW HAVEN, CONN.—It is reported that C. W. Blakeslee & Sons, of this city, have been awarded the contract for the building of a 35-mile third-rail system between Hudson and Albany, the work to be finished by July 1.

WARSAW, IND.—A committee representing the Logansport & Rochester Traction Company visited this city and decided to locate the principal power house here. The car houses and shops will also likely be erected here.

FAIRPORT, N. Y.—The Fairport village board has granted the right of way to the company which proposes to construct a trolley line from Rochester to Canandaigua, to run a branch of the road from Pittsford to this village.

SPENCER, MASS.—The Warren, Brookfield & Spencer Electric Railroad Company has asked the legislature for the privilege of raising $70,000 to purchase some new equipment for the road. New cars and other apparatus is needed.

HENDERSON, KY.—The Henderson Street Railway Company, it is said, is soon to be reorganized. The company interested in the reorganization will extend the lines, add new rolling stock, motors, etc., and have an almost entirely new plant.

VALPARAISO, IND.—The county commissioners have granted a franchise to Grant Michner and others for an interurban railway from this city to Michigan City, and to the West County line, where it will connect with the Northern Indiana Electric road to Chicago.

NIAGARA FALLS, ONT.—Bids for the construction of the new power house of the Niagara Falls Park & River Railway and International Traction Company, in Victoria Free Park, have been received, and the contract will be awarded within a few days from the Buffalo office.

BELAIR, MD.—A bill has been introduced in the legislature to incorporate the Belair & Havre de Grace Railway & Power Company. Capital stock $10,000, with privilege of increasing to $1,000,000. Incorporators, H. Reckord, H. H. Haines, W. E. Robinson, J. R. Massey and others.

ST. CLOUD, MINN.—It is stated here that the St. Paul Title & Trust Company, underwriters of the bonds of the Benton Power & Traction Company, will make application for a receiver of that concern, alleging the inability of the officials to meet interest charges falling due next June.

COALBURG, W. VA.—A charter has been granted to the Kanawha Traction & Electric Company, which proposes building an electric road between Coalburg and Kanawha Falls. The company is capitalized at $100,000, and among the incorporators is J. Q. Dickinson, of Charleston, W. Va.

PITTSBURG, PA.—A local political fight in the city of Allegheny is waxing so hot that the management of the United Traction Company has been compelled to issue an order to its conductors and motormen to refrain from discussing the political situation with the passengers on the street cars.

COLUMBUS, OHIO.—The Toledo & Michigan Railway Company has been incorporated, with a capital stock of $10,000, by Thomas H. Tracey, Harry E. King, Harry W. Lloyd, W. H. Spalding and Charles F. Chapman, Jr. The company will operate an electric line between Toledo and Monroe, Mich.

PHILADELPHIA, PA.—A charter has been applied for by the Moorestown Trolley Company, of Moorestown, N. J., to construct a trolley line from Moorestown to Merchantville. This will make a complete trolley road from Camden to Moorestown on the new road with probable connections with the Camden & Suburban Line now running to Merchantville from Camden.

MASSILLON, OHIO.—The Massillon city council has agreed to grant a franchise for 25 years to the Canton-Massillon Electric Railway Company, now operating between the towns, on condition that the company rebuild its entire system, adopting standard gauge; that it pay a yearly dividend of one-tenth of one per cent. after 15 years, and that it extend the line to Navarre, five miles south.

ST. LOUIS, MO.—A 2000-hp Westinghouse generator has lately been assembled at the new power house of the St. Louis Transit Company, and was put in operation March 10. Another 2000-hp machine arrived March 16, and two others are expected soon, which will greatly increase the facilities of the company for handling the increased traffic caused by the inauguration of the transfer system.

BELLEVILLE, ILL.—Articles of incorporation of the Mississippi Valley Transit Company have been filed. The company proposes to construct an electric road from East St. Louis to Edwardsville, Ill., via Collinsville. The incorporators are: C. F. Blanke, J. F. Conrad, Albert G. Blanke, August Holthaus, Henry Gans, George P. Heckel and Thomas B. Harlan, of St. Louis; Henry C. Squire, W. M. Warnock and Ferdinand Vorwald, of Edwardsville, and J. L. Wadsworth, of Collinsville. The capital stock is $500,000.

BROOKLYN, N. Y.—The report of the Brooklyn Heights Railroad Company for the quarter ending Dec. 31, 1899, shows the following results, compared with operations during the same period in 1898:

	1899.		1898.
Gross earnings	$2,804,915.10		$2,574,091.35
Operating expenses	1,799,987.47		1,895,963.55
Net earnings	$1,004,927.63		$678,127.80
Other income	73,306.46		60,269.25
Gross income	$1,078,234.09		$738,397.05
Fixed charges and taxes	1,061,181.91		1,107,026.25
Surplus	$17,052.18	(Deficit)	$368,629.20

A large part of the fixed charges includes rentals and interest which go back to the constituent companies, whose stock is owned by the Brooklyn Rapid Transit Company.

THE AUTOMOBILE.

MR. HIRAM P. MAXIM, JR., gave a graphic talk on Automobiles before the Knickerbocker Athletic Club, New York, on the evening of March 22.

THE FRIEDMAN AUTOMOBILE COMPANY has been incorporated at Chicago. Capital, $100,000. Incorporators, O. J. Friedman, W. W. Robinson, J. Rosenthal, all of Chicago.

THE SIMPLEX MOTOR VEHICLE COMPANY, of Kittery, Me., has been incorporated. Capital, $500,000. Incorporators: R. O. Hood, C. A. Keith, O. E. Jackson, A. H. Paton, all of Danvers, Mass.; F. E. Rowell, attorney, Kittery.

THE SPARKS AUTOMOBILE COMPANY is considering the advisability of locating a factory in San Jose, Cal. Propositions have been received from other points, and San Jose has been asked to offer the promoters some inducements to locate there.

THE FOSTER AUTOMOBILE MANUFACTURING COMPANY has been incorporated at Rochester, N. Y. Capital, $100,000. Incorporators: C. G. Foster, T. F. Younger, C. D. Martin, all of Rochester; Satterlee, Yoeman & Taylor, attorneys, Rochester.

THE PAINESVILLE AUTOMOBILE COMPANY, Painesville, Ohio, has been organized by E. J. House, Percy Smith, George W. Blackmore and others to operate an automobile 'bus line between that place and Fairport, a distance of three miles. A vehicle to carry twenty people has been contracted for, and more will be ordered if this proves satisfactory.

NEW INDUSTRIAL COMPANIES.

THE ELECTRIC HOUSE LIGHTING COMPANY, of Chicago, has been incorporated. Capital, $2500. Incorporators: H. K. Greenman, E. A. Biggs, J. Frank, all of Chicago.

THE ECKHARD MOTOR COMPANY, of Brighton, Monroe County, N. Y., has been incorporated, with a capital of $30,000. The directors are John Eckhard and C. E. Butterfield, of Brighton.

THE INTERNATIONAL ACHESON GRAPHITE COMPANY has been incorporated at Trenton, N. J., with a capital stock of $3,000,000, to manufacture graphite, carbon and other graphite articles.

CARBON COMPANY IN CANADA.—Capitalists of Montreal city and Ottawa have arranged for the formation of a company to build a big carbon plant at Chicoutimi, the capital being $2,000,000.

THE GEORGIA-CAROLINA MANUFACTURING COMPANY, of Hartwell, Ga., has been chartered to develop the water power on the Tugalo River, at Hatton's Ford. The capital stock is reported to be $100,000.

THE NEW ERA ELECTRIC DRILL CO., Colorado Springs, Col., has been incorporated. Capital, $1,000,000. Incorporators: A. J. Clark, H. N. Hawkins, J. McDonough, M. C. Jackson, W. Thorn, W. C. Allison, all of Colorado Springs.

THE SUBMERGED ELECTRIC MOTOR COMPANY has been organized in Menomonie, Wis. The officers are: President, J. H. Stout; vice-president, S. N. Smith; secretary and treasurer, John Hapwood. The capital stock of the corporation is $50,000. This company is owner of the submerged electric motor, a recent invention of I. N. Smith, of Minneapolis, and Tracy B. Hatch, of Chicago. The device is not only an invention, but also a discovery, and, it is stated, offers the first solution of the problem of successfully operating an electric motor under water.

LEGAL.

RECEIVER FOR A THIRD AVENUE SUBSIDIARY LINE.—Judge Lacombe, in the United States Circuit Court, has appointed Hugh J. Grant temporary receiver of the Forty-second Street, Manhattanville & St. Nicholas Avenue Railway, New York, upon the application of the Lorain Steel Company and a creditor of the Third Avenue Railroad in the sum of $170,594.67 for material used in construction work.

ALLEGED INFRINGEMENT OF TROLLEY POLE PATENTS.—Papers were filed in the United States Court, of the Pittsburg district, in a suit brought by the Pittsburg Trolley Pole Company against the Pittsburg Tubular Steel Whiffletree Company. The action is based upon an alleged infringement of patents claimed to be owned by the plaintiff company, by which it is enabled to taper any hollow iron in the form of the present almost universally used trolley pole. The patent is said to be an invention of Robert Gracey, who sold it to the company in 1894.

PERSONAL.

DR. THOMAS ADDISON, Pacific Coast district engineer of the General Electric Company, recently left San Francisco for New York. Thence he expects to go to Europe to spend several months.

MR. O. H. KIRK, of the Westinghouse Electric & Manufacturing Company, has started for Kobe, Japan, where he will represent the company in the Far East. His bailiwick will include Siberia, Corea, China and the Philippines.

COL. F. H. STRIEBY, of the railroad supply department of the General Electric Company's Cincinnati branch, is in New York, assisting in the work of financing an important electric road to be built in the vicinity of Cincinnati this summer.

GENERAL A. W. GREELY, Chief Signal Officer, United States Army, was in Pittsburg last week, in consultation with the management of the Standard Underground Cable Company about the proposed Pacific Cable. General Greely also visited the Westinghouse factory at East Pittsburg.

MR. F. H. WARD, formerly owner and manager of the Novelty Electrical Supply Company, of Williamsport, Pa., and more recently engaged in contract work in the south, has organized the Electrical Contracting & Supply Company, with offices in Williamsport, Pa., and Ithaca, N. Y.

MR. ARTHUR S. VANCE has joined the selling staff of the C & C Electric Company and, for the present at least, will operate from the company's main office in New York. Mr. Vance has had many years of practical experience in the electrical field, and his experience and extensive acquaintance should prove of great value to the C & C Company.

OBITUARY.

STEPHEN P. M. TASKER, of the firm of Morris & Tasker, Philadelphia, Pa., died at his home in that city on March 19, at the age of 66 years.

FRANK O. MASON, superintendent of the New Castle, Pa., Traction Company, died at his home in that place on March 22, aged 28 years. He was born in Ohio.

MRS. AMELIA DICKINSON POPE, widow of the late Franklin Leonard Pope, died of heart failure in Amherst, Mass., on March 20. The funeral service was held at Amherst on the 22d and the interment was at Great Barrington, Mass., on the following day. Her only son Leonard is at Amherst College, the eldest daughter, Anna, at the University of Wisconsin, and the youngest daughter, Amy, at Smith College, Northampton, Mass.

MR. W. J. MACCONNELL died at Philadelphia, March 25, of paralysis following a severe attack of grip. Mr. MacConnell was well known and highly esteemed in the electrical trade, having for some years been in charge of the Chicago office of the *Electrical Engineer*, and for a time in charge of the Philadelphia office of the ELECTRICAL WORLD AND ENGINEER. More recently he had been on the staff of the *Engineering Magazine*. Mr. MacConnell left a wife and young child.

Trade Notes.

THE DEVERE ELECTRIC COMPANY, of Cincinnati, has in charge the construction of a handsome scenic railway for Coney Island, New York.

THE LAWTON-BEATTIE COMPANY, of Cincinnati, will put the finishing touch to the work recently completed on the Government building in that city.

THE MORGAN ENGINEERING COMPANY, of Alliance, Ohio, has recently completed a 30-ton electric traveling crane for the William Tod Company, of Youngstown.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is exploiting the full line of Dayton fan motors, and is anxious to hear from the trade as to their requirements for the season.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has lately established an office in Atlanta, Ga., in the English-American Building. Mr. R. J. Russell is in charge.

TO EXTEND CARBON WORKS.—The National Carbon Company, at a meeting of the directors in Cleveland recently, decided upon extensive improvements to the principal plant in that city.

THE SHAWINIGAN FALLS POWER HOUSE.—The new power house for the Pittsburg Reduction Company at Shawinigan Falls, Quebec, Canada, will be furnished by the Berlin Iron Bridge Company, of East Berlin, Conn.

PRESIDENT GEORGE BULLOCK, of the Bullock Electric Manufacturing Company, Cincinnati, is again at his desk, after an absence of several weeks in New York. The company will not put up an independent gas plant, as was recently contemplated.

ARCTIC BATTERY FAN MOTORS.—Mr. John E. Fuller, 93 Maiden Lane, New York, has just issued a catalogue of Arctic battery fan motors, of which he is manufacturer. These motors are made in various sizes, and besides being breeze producers may be used for light power work, such as operating sewing machines, etc.

THE EMPIRE ELECTRIC TRACTION COMPANY.—The shareholders of this company have decided to dissolve the corporation because of there being no further purpose for its existence. The company, which had a capital of $100,000, owned patent rights which have been sold to the Doty Third Rail Electric Company.

TRUSTEE'S SALE.—The trustee of the Morris Arc Lamp Company of Chester, Pa., Albert Dutton MacDade, will on April 11, offer for public sale all of the machinery, fixtures, rights, franchises, stock, etc., of that concern. Trustee MacDade says that with proper management this plant can soon be placed on a profitable basis.

LINEMAN'S CLIMBERS.—Mr. J. J. Reidy, 311 East Street, New Haven, Conn., has just arranged to supply the Western Union Telegraph Company with Donnelly improved climbers for linemen. The list of corporations and supply houses which now use and sell the Donnelly climber includes all of the more important names of the country.

THE COLONIAL ELECTRIC COMPANY.—The new factory of the Colonial Electric Company, at Ravenna, Ohio, commenced operations last week. All of the machinery has been removed from the former factory at Youngstown, and nearly all of it has been put into place. About 25 of the old employees are now at work, and the force will be greatly increased in a few days.

THE TRIUMPH ELECTRIC COMPANY, of Cincinnati, has just completed for the Baltimore & Ohio Southwestern Railway Company a special 125-kw, six-pole, direct current, 125-volt generator, to be placed in the company's shops at Washington, Ind. The new machine is to furnish the increased power demanded by the addition of a number of improved machine tools to the shop equipment.

THE HOEFFNER REFINING COMPANY, of Hamilton, Ont., has placed an order with the Canada General Electric Company for two 1500-amp., 120-volt generators, to be used for electrolytic purposes. These machines are to be direct connected to Stanley motors, and the power will be supplied by the Cataract Power Company, of Hamilton, from the DeCews Falls transmission lines.

THE EMERSON MANUFACTURING COMPANY, St. Louis, Mo., has established an eastern branch office at 136 Liberty Street, New York. One of

the officers of the company will be in charge of the office, which will not be a mere sales agency, but a branch office of the company. A large stock of all types and sizes of Emerson motors will be kept, and thus assure prompt shipment on all orders.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY is installing a lot of new machine tools in the old United States Electric Company's plant in Newark, N. J. Machine tools to the value of $25,000 have been purchased within the past few days for this purpose.

THE CHARLES MUNSON BELTING COMPANY, Chicago, Ill., has found it necessary to move into larger quarters in order to better care for its increasing business. Its new location is at 33-37 Ontario Street, the building having been especially arranged for its purpose. The company's offices and display rooms will occupy a separate building at the corner of Canal and Washington streets. The company has a new catalogue on the press, which will soon be ready for distribution.

THE PATERSON & PASSAIC AUXILIARY FIRE ALARM TELEGRAPH COMPANY, which was recently incorporated with a capital stock of $30,000, has bought out the Gamewell Auxiliary Fire Alarm Company, which has been carrying on business in Paterson and Passaic for several years past. The officers of the new company are F. C. Van Dyk, president; C. R. Newman, of Passaic, vice-president, and Robert H. Fordyce, secretary and treasurer. The concern installs auxiliary fire alarm boxes in mills and factories.

THE WESTERN ELECTRIC COMPANY, in addition to its large line of conduit for interior wiring, has placed in stock the Greenfield flexible steel conduit. This conduit is easily bent in any direction, but is extremely rigid so far as compression is concerned. One of the particular uses to which it is adapted is as a covering for lamp cord. Flexible lamp cord is inserted in the conduit for use with portable lamps and devices for stage illumination. With this steel covering the flexible cord is entirely protected from abrasion or other mechanical injuries.

LUNDELL FANS FOR COL. PAINE'S YACHT.—The Sprague Electric Company has recently received an order for two 18-inch Lundell fans for use on board the steam yacht belonging to Col. Oliver H. Paine, and which is preparing for a trip around the world. These fans are arranged to ventilate the engine room by the plenum-vacuum system of ventilation. In addition to these are some 17 Lundell fans of the bracket pattern located in the cabin, staterooms and smoking room. They are finished to correspond with the interior decorations of the yacht.

BELT PULLEY DRESSING.—The Warren Manufacturing Company, 65 South Canal Street, Chicago, Ill., has just issued some attractive literature relating to the "Warren Liquid Pulley Cover." This is a paint which is applied to the face of a pulley, giving it an enameled surface which makes it adhesive. The covering, in fact, is so leather-like in appearance, it is stated, that it has often been taken for an actual cover of leather. This pulley paint is offered as an admirable substitute for leather pulley lagging, which has been used so extensively on all kinds of machinery.

THE AMERICAN CIRCULAR LOOM COMPANY will, on March 31, remove its Chicago office from the Marquette Building, taking a well-fitted and commodious store at 141 Clinton Street, where it will carry a large stock of steel conduit "Electroduct." Mr. George W. Patterson, the company's Western representative, will also continue to handle the Gordan primary battery. This line he reports is especially prosperous this spring, the western business having doubled in the last six months, owing principally to the extensive adoption of the Gordon cell in central energy telephone work.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, has shipped to its eastern office and warehouse in New York City the first instalment of this season's stock of fan motors. This first shipment consists of a carload of assorted ceiling, desk and bracket fan motors, which will be followed by additional carloads to insure that at all times a large and well assorted stock of 1900 model Emerson fan motors and ceiling fans will be on hand. The New York office of the Emerson Company is organized to give thoroughly satisfactory service and prompt shipment to the trade in the eastern territory.

DRAFT WITHOUT A CHIMNEY.—The B. F. Sturtevant Company, Jamaica Plain, Mass., publishes an interesting little pamphlet on the subject of draft without a chimney. Its own experience in this regard is not an exceptional one; it can be practically duplicated in any case. Those interested in the generation of steam should study this subject for their own information and profit. The Sturtevant Company has just issued a third edition of bulletin G, in which the principal features of Sturtevant generating sets with automatic horizontal and upright engines are briefly described. The dimensions and other data are given in tables, and machines of the two types are illustrated.

MOORE'S WIRE WORKS BURNED.—Fire destroyed the building at the corner of Third and Race streets, Philadelphia, in which was located the works of Alfred F. Moore, one of the oldest electric wire houses in the country. It is supposed that the fire started in the boiler rooms in the basement. The first floor was occupied by machinery. The second and third floors were used for the manufacture of magnet wires, and the fourth and fifth for line wires. The floors of the building were well soaked with insulating compounds, which greatly aided the spread of the flames. The building was a five-story structure, and was, with its contents, a total loss. Mr. Moore places his loss at $250,000.

PITTSBURG FEED-WATER HEATER COMPANY.—A charter was granted on March 14 to the Pittsburg Feed-Water Heater Company, of Pittsburg. Mr. James Bonar is president, J. E. Schlioper, treasurer and general manager, and Joseph Crawley, secretary. The sales department will be under the control of James Bonar & Co., of Pittsburg, as heretofore. The company will manufacture the Pittsburg feed-water heaters and purifiers, and also the Pittsburg tubular feed-water heaters. These heaters have been in use for the past six years, and have been adopted by some of the leading steam users. It is the intention of the company to push the sale of these heaters, and it is desirous of making arrangements with different concerns throughout the United States to take hold of its product in the various sections.

THE E. W. BLISS COMPANY AT THE PARIS EXPOSITION.—The E. W. Bliss Company, of Brooklyn, N. Y., is shipping to France over 100 cases of its machines for exhibition purposes, both at Champ de Mars and at Vincennes, during the coming Paris Exposition. The total weight of these machines will be in the neighborhood of 200,000 pounds. Among the interesting machines which it intends to exhibit are an automatic can-body forming and lock-seaming machine, a new style toggle drawing press, an automatic notching machine, spinning lathes, single-action presses, double-action presses, drop hammers, double-crank presses, heavy punching presses, screw machines for sheet metal screws, power squeezers, shears, and many other machines of particular interest to those who make articles from sheet metal. The Bliss Company's exhibit will also contain a large number of machines specially adapted for the manufacture of armature discs and sections.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED MARCH 20, 1900.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

645,547. DRY GALVANIC ELEMENT. Wilhelm Botz, Ludwigs-Hafen, Germany. App. filed April 1, 1899. A storage battery is sealed with a blanket saturated with oil, an air space existing between the blanket and the electrolyte. The oil blanket has the effect of setting gases free at any time, while at ordinary pressure water or liquids are detained by it.

645,552. COMBINED SLEEPER AND CONDUIT FOR ELECTRIC RAILWAYS; W. Courteney, New York, N. Y. App. filed July 17, 1899. The string piece upon which the rail rests is provided with longitudinal passages for electric conductors.

645,553. MINE HAULAGE LOCOMOTIVE; C. E. Davis, Chicago, Ill. App. filed May 31, 1894. The invention consists of certain swiveling joints between the armature shaft and axle which permit the wheel to follow the inaccuracies in the track without straining the gearing.

645,573. ELECTRIC MINE BELL; B. Searle, Montrose, Pa. App. filed Aug. 7, 1899. To prevent the sparks at the contacts of the bell from igniting any existing gas, the mechanism of the bell is located in a hermetically sealed casing, the parts which project therefrom passing through liquid seals.

645,569. RECEPTACLE FOR STERILIZING PERISHABLE SUBSTANCES; Isaiah L. Roberts, New York, N. Y. App. filed Nov. 18, 1896. Cans or other vessels for preserving meats, fruits and other food articles are provided with an interior insulated electrode extending through the provisions in the can. By this means an alternating current may be passed through the contents of the can, thereby destroying any living germs or organisms without altering or impairing the natural quality of the food.

645,570. TELEPHONE APPLIANCES; Charles E. Scribner, Chicago, Ill. App. filed June 18, 1896. A storage battery for supplying current to the transmitter is continually charged during its idleness by means of primary batteries, the storage and primary cells being so related to each other that the current supplied by the latter shall be just sufficient to retain the former fully charged.

645,571. TELEPHONE EXCHANGE APPARATUS; Charles E. Scribner, Chicago, Ill. App. filed Nov. 16, 1896. The patent embraces a number of different features relating to the charging of a local storage battery from the line conductors to the sub-station signal bell; the connection of the return circuit at the sub-station; a means for automatically setting a line signal in the use of a sub-station telephone; for effacing that signal in making connection with a line, and for substituting for the line signal a supervisory signal.

645,572. AUTOMATIC CALLING APPLIANCE FOR TELEPHONE TRUNK LINES; Charles E. Scribner, Chicago, Ill. App. filed March 9, 1898. The invention applies to incoming trunk lines for use in making connection with telephone lines provided with means for altering the resistances of the line circuit in the use of the telephone. It provides simplified apparatus and circuits for applying and removing the operator's telephone or other testing appliance; for applying and withdrawing a source of calling current; for ringing the bell at the station to be called, and for controlling the display of a signal lamp associated with the trunk line in the switchboard.

645,576. SYSTEM OF TRANSMISSION OF ELECTRICAL ENERGY; Nikola Tesla, New York, N. Y. App. filed Sept. 2, 1897. (See Current News and Notes.)

645,588. FIRE ALARM APPARATUS; A. F. Doddridge, Chicago, Ill. App. filed Oct. 28, 1899. This is an automatic system in which an alarm is sounded continuously at the immediate location of the fire, besides giving an alarm at a central station. This directs the firemen to the exact location at once.

645,599. AUTOMATIC FIRE ALARM; C. Law, Pittston, Pa. App. filed May 29, 1899. A binding post carrying a spring is attached to one side of the circuit while another binding post containing a slot through which the spring passes is attached to the other wire. The latter binding post is of insulating material and contains a fusible plug which holds the spring out of contact with the wire. When the fuse melts the spring traverses the slot and engages the wire.

645,603. DEVICE FOR LOCATING GROUNDS ON ELECTRIC CIRCUITS; M. J. Myers, Syracuse, N. Y. App. filed June 17, 1896. The device includes an indicator, oppositely acting magnets for moving the indicator, the magnets being connected to the two sides of the circuit and a battery connected to both magnets and to the ground. The location of the ground is shown by the indicator.

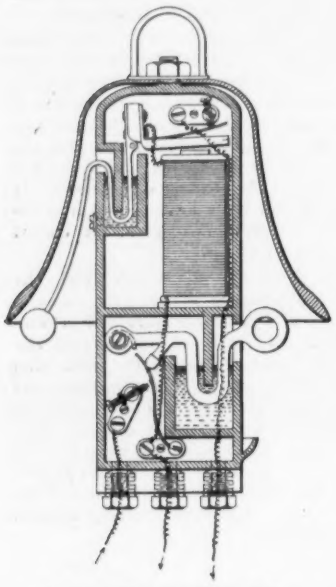
645,612. METHOD OF DISTRIBUTING ENERGY; G. Westinghouse, Pittsburg, Pa. App. filed Jan. 11, 1899. (See Current News and Notes.)

645,613. APPARATUS FOR DISTRIBUTING ENERGY; G. Westinghouse, Pittsburg, Pa. App. filed Nov. 13, 1899. (See Current News and Notes.)

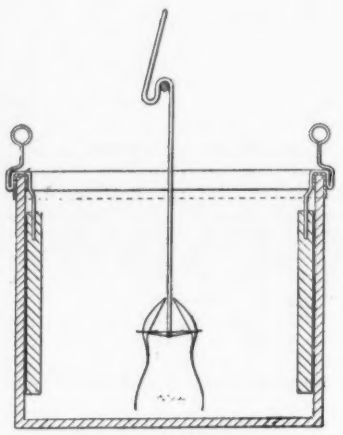
645,615. ELECTRIC INSULATION FOR RAILWAYS; J. E. Wright, Omaha, Neb. App. filed Feb. 25, 1899. A housing is placed just under the tread of the rail; inside of it are two insulating blocks between which the conductor is placed. A collecting wheel from the car passes under and makes contact with the conductor.

645,640. STORAGE BATTERY CELL; Rufus N. Chamberlain, Depew, N. Y. App. filed Aug. 29, 1899. A duplex or multiple cell having a partition separating the adjacent cells and provided in its top with a depression which forms a trap for intercepting moisture.

645,646. ELECTRIC RAILWAY; E. C. Morgan, Chicago, Ill. App. filed Sept. 2, 1898. Wheels carried by the truck and driven by the motor grip the opposite side of a central rail and thereby create a traction which carries the car along. The wheels are in a horizontal plane and can be tilted downward in the direction the truck is moving and cause the truck wheels to hug the track.



645,573.—Electric Mine Bell.



645,785.—Holder for Electroplating.

645,647. THIRD OR TRACTION RAIL FOR ELECTRIC RAILWAY; E. C. Morgan, Chicago, Ill. App. filed Nov. 30, 1898. An improvement on the preceding invention wherein the conductor is located in a groove formed in the rail which is gripped by the traction wheels, and the conductor is provided with means for keeping it taut.

645,648. ELECTRIC RAILWAY; E. C. Morgan, Chicago, Ill. App. filed Nov. 30, 1898. A modification of the preceding patent to the same inventor consisting in means for setting up the gripping wheels without changing the mesh of the gears.

645,654. THIRD RAIL FOR ELECTRIC RAILWAY; W. A. P. Willard, Jr., Hull, Mass. App. filed July 13, 1899. Details of a contact box.

645,671. ELECTRIC METER; E. W. Rice, Jr., Schenectady, N. Y. App. filed Dec. 20, 1899. (See Current News and Notes.)

645,674. REGULATION OF DYNAMO ELECTRIC MACHINES; C. P. Steinmetz, Schenectady, N. Y. App. filed Dec. 15, 1899. (See Current News and Notes.)

645,675. HIGH POTENTIAL APPARATUS; Elihu Thomson, Swampscott, Mass. App. filed Dec. 26, 1899. (See Current News and Notes.)

645,684. ELECTRICALLY OPERATED SWITCH; E. M. Hewlett, Schenectady, N. Y. App. filed Dec. 30, 1898. This is a railway switch box in which the switch is moved to the closed position by a circuit carrying a heavy current, and maintained in the closed position by a circuit carrying a lighter current.

645,690. SECTION INSULATOR AND SWITCH THEREFOR; G. R. Mair, Schenectady, N. Y. App. filed Dec. 11, 1899. The trolley wire is divided into sections and mechanical switches are arranged at the junctions. The trolley throws the switch to close the circuit through the section ahead and cut off the section at the rear, devices being provided to prevent sparking.

645,736. LOW WATER ALARM; W. D. McLauchlin, Corunna, Mich. App. filed Dec. 15, 1899. A pipe passes through the boiler to a point just below the low water line; when the water uncovers the end of the pipe, steam rises therein and heats the upper end of the pipe which projects from the boiler, causing an expansion of the part which is used to close an alarm circuit.

645,750. STORAGE BATTERY; Patrick Kennedy, New York, N. Y. App. filed March 16, 1899. A plate is made of India rubber or other suitable non-conductor of some degree of elasticity, and of cellular construction, the active material being contained in the cells and connected with conducting bars in grooves at the side of the plate.

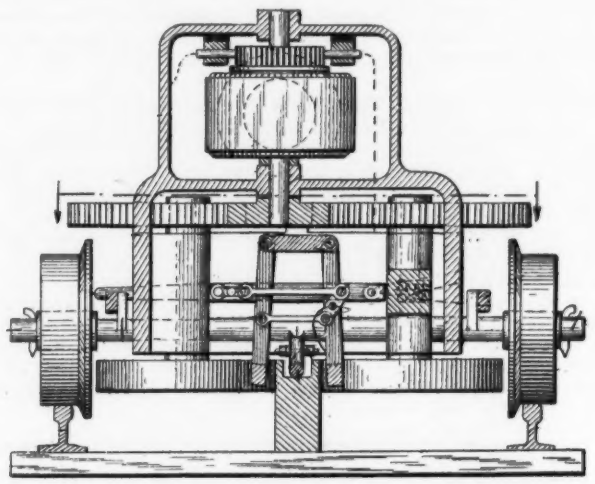
645,764. TRAIN CONTROLLING APPARATUS FOR ELECTRIC CARS; A. Sundh, Yonkers, N. Y. App. filed Aug. 17, 1899. The controllers on the several cars of a train are all mechanically connected together by belts and pulleys so that the entire train can be controlled from any controller on the train.

645,765. CONTROLLING APPARATUS FOR ELECTRIC CARS; A. Sundh, Yonkers, N. Y. App. filed Aug. 26, 1899. Step by step motors are geared to the shaft of the several controllers on a train. The motors are all connected together and each controller operates a switch which is responded to by the several motors, so that all controllers can be operated from any one controller.

645,766. CONTROLLING DEVICE FOR MECHANICAL APPARATUS; A. Sundh, Yonkers, N. Y. App. filed Sept. 9, 1899. This invention consists of a manually rotatable circuit closer electrically connected with a constantly charged conductor and combined with one or more self-breaking branch circuits provided with mechanically rotated terminals for the purpose of manually effecting the starting of an intermittently working machine and concurrently prearranging for the greater or less duration of such working and the automatic stopping of the machine.

645,767. CONTROLLER FOR ELECTRIC RAILWAY CARS; A. Sundh, Yonkers, N. Y. App. filed Sept. 25, 1899. In this case the controllers are operated by compressed air motors, which in turn are actuated by electromagnetic valves under the control of the motorman, all controllers being connected together to be operated by either one of them.

645,774. CONTINUOUS CURRENT TRANSFORMER; A. Wydts and G. Weissmann, Paris, France. App. filed May 12, 1899. (See Current News and Notes.)



645,646.—Electric Railway.

645,784. ELECTRIC ARC LAMP; E. L. Bowen, McComb City, Miss. App. filed Dec. 8, 1899. Details of the carbon regulating mechanism.

645,785. HOLDER FOR ELECTROPLATING; W. Y. Buck, Bristol, Conn. App. filed Sept. 22, 1899. The holder is so shaped as to sustain spoons or forks face to face, thereby enabling them to receive heavier plating on the back than on the front.

645,786. ART OF ELECTROPLATING; W. Y. Buck, Bristol, Conn. App. filed July 15, 1899. This patent covers the method of plating indicated in the preceding patent.

645,809. CONTROLLING DEVICE FOR ELECTRIC SWITCHES; Edward W. Hammer, Chicago, Ill. App. filed Aug. 29, 1899. The motion of the arm of a rheostat is controlled by a frictional strap connected with the armature of an electromagnet. In starting up a motor, the rheostat arm is moved along the contacts and held by means of the frictional strap in any of its various positions as long as the normal current corresponding to that position passes through the magnet.

645,839. SIGNAL FOR RAILWAYS; C. A. Stimpson, Philadelphia, Pa. App. filed Aug. 8, 1899. The signaling circuit takes current from the trolley wire, the switches being operated by the trolley.

645,910. PROCESS OF LOCATING METALLIC MINERALS OR BURIED TREASURE; F. H. Brown, Chicago, Ill. App. filed July 17, 1899. The process consists in establishing a circuit of alternating current through a definite distance of the earth, measuring the resistance of such current, then establishing a circuit of similar current through the same distance of the earth at various other points in the same vicinity, and measuring the resistance to such current at each point, and finally comparing such measurements.

645,917. TELEPHONE CALL REGISTER; William Gray, Hartford, Conn. App. filed Oct. 29, 1898. A primary register is combined with a main register. One register has a record of only sufficient numbers for the calls of a single day, and fifteen of its movements are required to change the number on the main register, which has a large record capacity.

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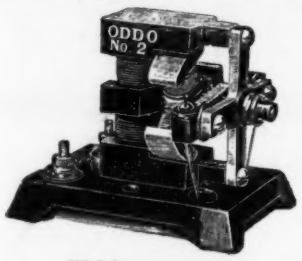

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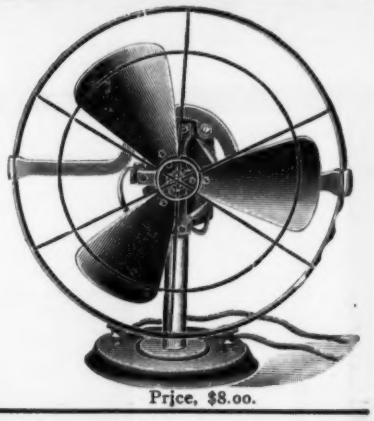

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Continued on Page 50.

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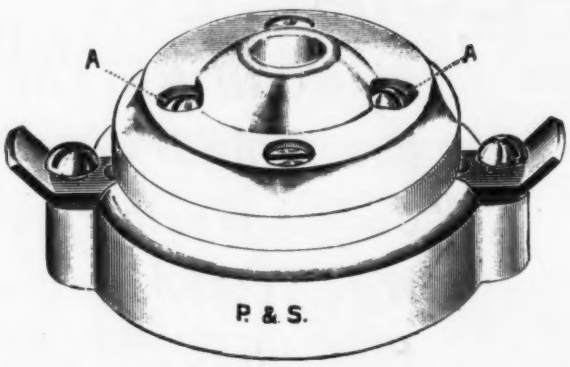

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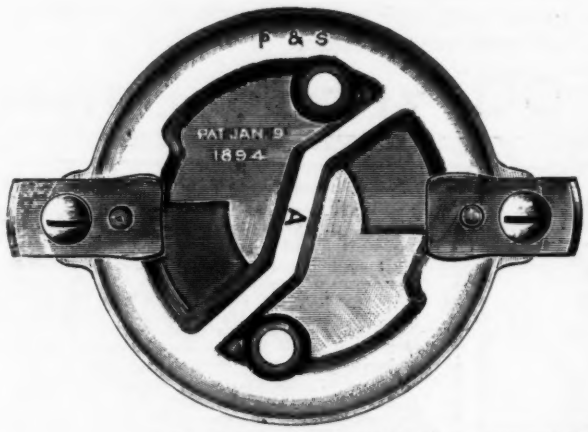

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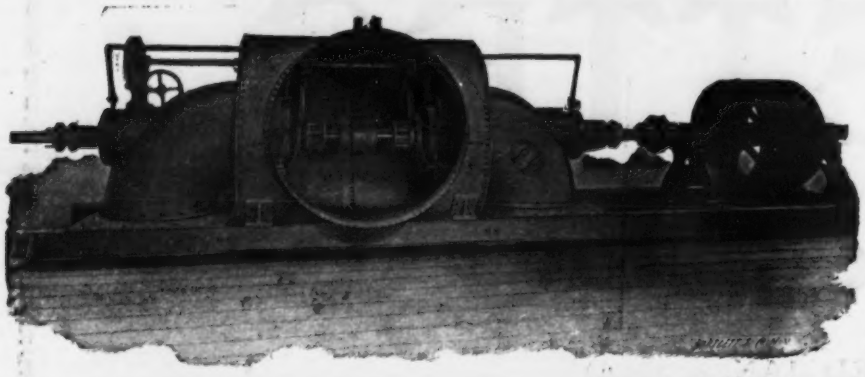

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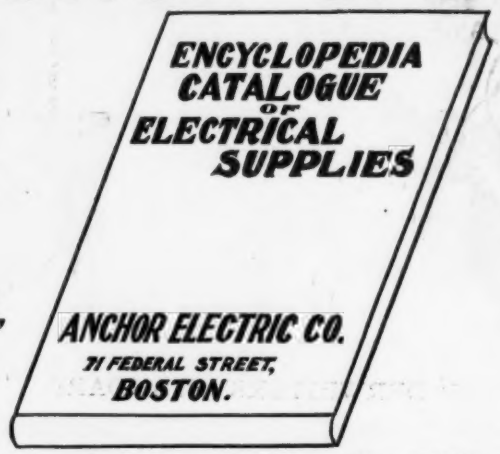

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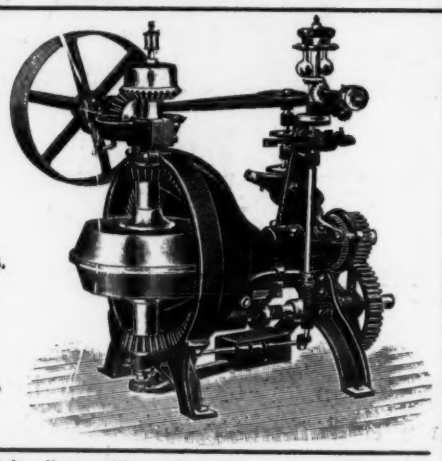

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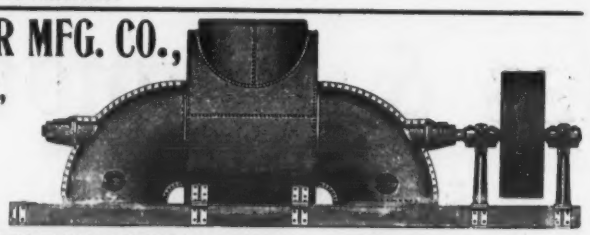

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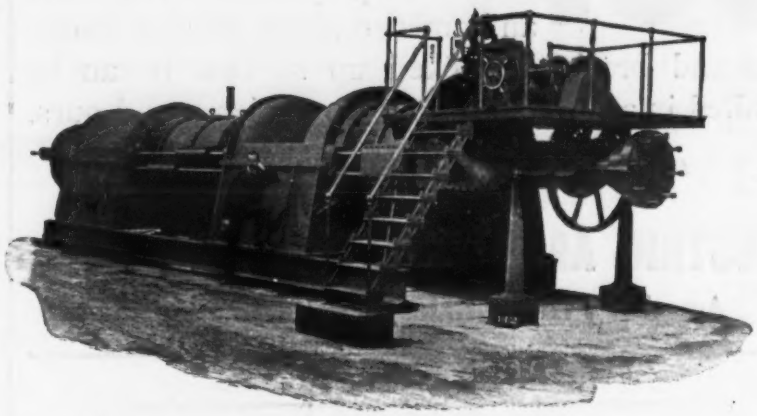

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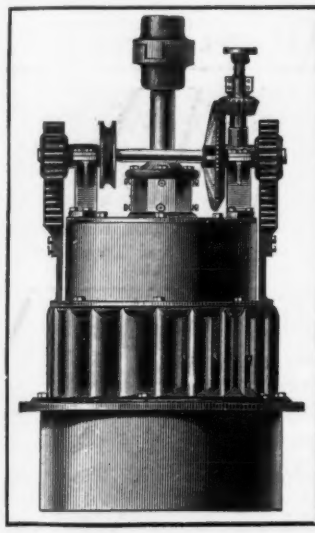

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